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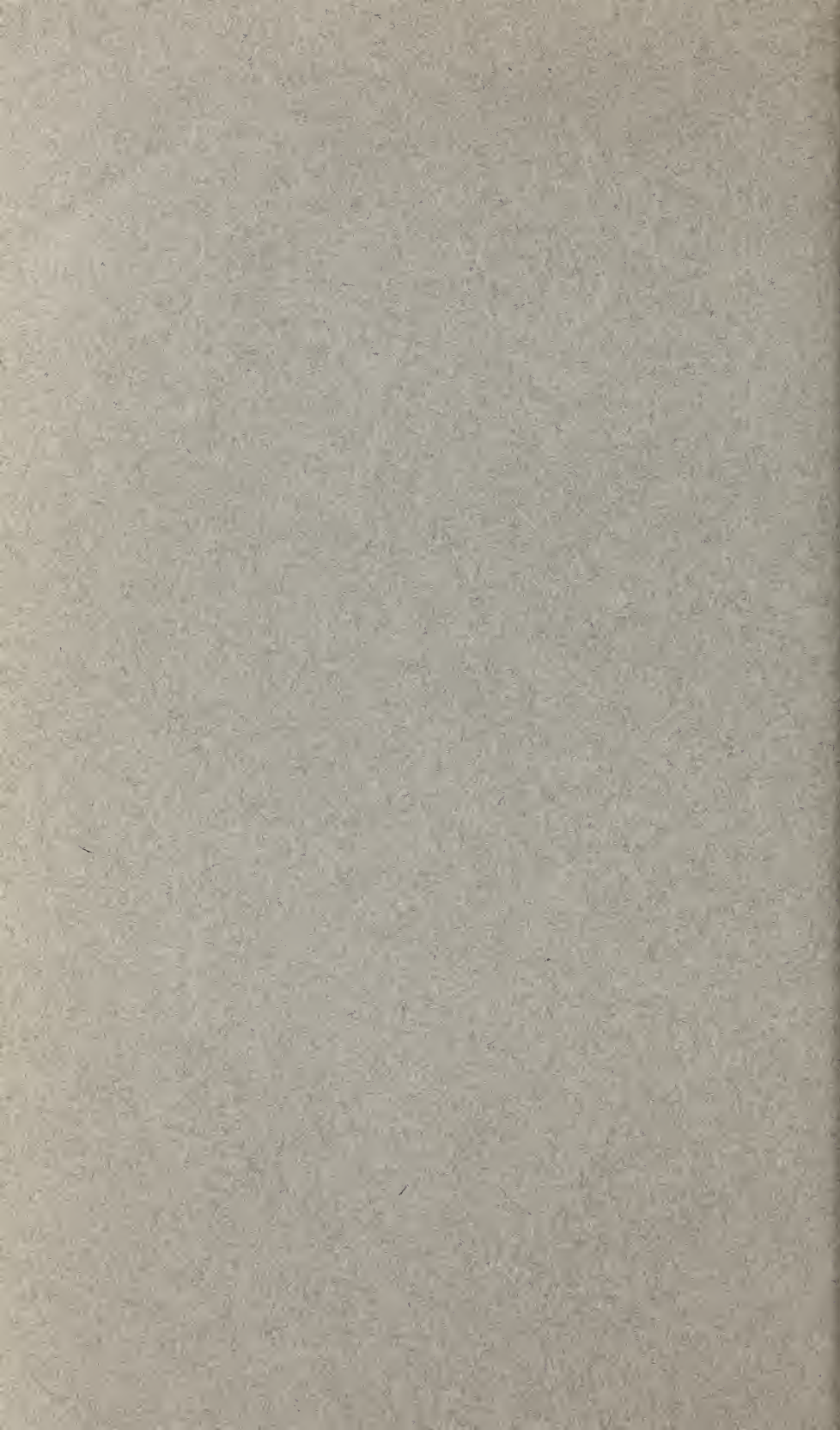
**WASHING, CLEANING, AND
POLISHING MATERIALS**

CIRCULAR C424

Bureau of Standards

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U. S. DEPARTMENT OF COMMERCE

HARRY L. HOPKINS, Secretary

NATIONAL BUREAU OF STANDARDS

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CIRCULAR OF THE NATIONAL BUREAU OF STANDARDS C424

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WASHING, CLEANING, AND POLISHING
MATERIALS

By F. W. Smither

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PREFACE

For more than 25 years the National Bureau of Standards has been testing soaps and other detergents for various governmental agencies. During this time hundreds of requests for information about these materials have been received from the general public as well as from officials of the Government. To give more complete information than would be feasible in a letter, the Bureau issued in 1916 its Circular C62, Soap. A second edition was published in 1919, and a third in 1923. Because so many letters asked for more data on soaps and for information on dry cleaning, polishes, etc., Circular C383, Washing, Cleaning, and Polishing Materials, was written (to supersede Circular C62). Circular C383, issued in September 1930, has been in great demand, about 11,850 copies having been distributed.

Since 1930 there have been noteworthy advances in the detergent field, and new products have been introduced on a commercial scale. For the present circular the material presented in Circular C383 has been thoroughly revised and enlarged. Suggested formulas are given for automobile, floor, furniture, metal, and shoe polishes, sweeping compounds, and other items, and new subjects are discussed. It is believed that the present circular is a distinct improvement on the one it supersedes.

LYMAN J. BRIGGS, *Director*.

WASHING, CLEANING, AND POLISHING MATERIALS

By F. W. Smither

ABSTRACT

This publication discusses briefly the use of water in laundering, pointing out the effects of impurities in water and means for their elimination. A brief description of the general composition of soap, soap-manufacturing processes, and the common varieties of soap products is followed by short discussions of alkaline cleansers and miscellaneous detergents and detergent or laundry aids, such as alkyl sulfates and sulfonates, sulfonated oils, special phosphates, bleaches, sour, bluing, and starch. Brief discussions are also included on dry-cleaning operations, solvents, dry-cleaning soaps, stain removal, finishing, reclamation of solvent, elimination of static electricity in dry-cleaning plants, and carpet and upholstery cleaners. Sections are devoted to furniture and automobile polishes, metal polish, floor wax and polish, glass polish and cleaner, stove polish, shoe polish, polishing cloths, dust cloths, sweeping compounds, wall-paper cleaner, and floor oils. A list of the Government specifications for the products covered, numerous literature references, and suggested formulas for some items are also given.

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I. INTRODUCTION

To answer many mail inquiries from the public, the National Bureau of Standards has issued numerous circulars on special topics. In 1930, Circular No. 383, on Washing, Cleaning, and Polishing Materials, was issued to meet the demand from the general public and to cover topics not discussed in an earlier publication by the Bureau (Circular No. 62 on Soap). During the past 8 years, there have been noteworthy advances in the detergent field, including the introduction of new products on a commercial scale. The present circular is a thoroughly revised edition of Circular No. 383. It contains new formulas and discusses subjects that were not included before. It is designed to give information in a concise and popular form.

II. SOAP SOLUTIONS AND CLEANSING ACTION

Although many theories have been put forward to explain the detergent or cleansing action of soap, or other detergent solutions, the question may be considered as still unsettled. The following brief discussion is intended to explain in part some of the properties of soap solutions as used in laundering processes.

Dirt can be removed if a film of liquid can be forced between it and the fabric or other material. Obviously of major importance is the ability of the solution to wet readily the fabric and foreign matter. Drops of pure water assume a spherical shape and are slowly absorbed by fabrics; the surface of the water acts as if it were an extremely thin elastic skin. The force which causes a volume of liquid to take a form with the least surface area (a globe or sphere) is known as surface tension. Solutions of low surface tension will wet surfaces with which they come in contact more readily than will solutions of high surface tension. Soap is one of the most effective agents for lowering the surface tension (breaking or weakening the surface skin) of water, and so increases the wetting power of the solution.

When a fatty oil and water are shaken together, the oil is distributed through the water in the form of small drops, and after standing, the oil and water separate into two distinct layers. When the water is replaced by a soap solution, the oil is distributed or dispersed throughout the solution in the form of a fine suspension. The "milky" solution is known as an emulsion. In the latter case the drops of oil are so small that a long time is required for them to coalesce to larger drops and separate out. The property of soap solutions and alkaline solutions to produce emulsions with oils or fats is known as emulsifica-

tion and is one of the properties which enable them to remove grease and oil.

On adding soluble soap or solutions of soap to a hard water, the calcium, magnesium, iron, or other elements that cause hardness in water will react with the soap to form insoluble soaps. The use of hard water not only wastes soap, but may cause very poor laundry work by the deposition of these insoluble soaps on the fabrics. "Soft water" is water that is free from the substances that produce insoluble soap compounds, and water softening consists in removing these materials from the water, usually as finely divided insoluble compounds.

No satisfactory test has been devised for measuring the detergent power of a soap and, therefore, large users of soap buy such products on specifications based on chemical analysis.

The process of washing consists essentially of the following three stages: (1) Wetting the fabric and the dirt; (2) removing the dirt from the fabric; and (3) retaining the removed dirt in suspension in the washing solution and preventing it from redepositing on the fabric, particularly when the solution is diluted by rinse water.

In the dry-cleaning process the fabrics are immersed in a fluid other than water. In this process the wetting and solvent power of the dry-cleaning solvent, action of dry-cleaning soaps, and mechanical agitation are the main factors. In general, the cleansing action of the solvent and other detergents is, in part at least, similar to that outlined above.

III. WATER

1. IMPURITIES

First in importance and volume of the materials used in the so-called wet-washing operations is water. All natural waters contain impurities which, for convenience, may be divided into two classes—suspended and dissolved impurities. The suspended matter (clay, etc.) that will affect washing operations can be removed by proper filtration and sedimentation. The dissolved impurities may be divided into two groups—(1) those that cause hardness, and (2) those that do not cause hardness.

2. HARDNESS

Hardness is often expressed in degrees or grains per United States gallon, calculated as calcium carbonate (CaCO_3); that is, 1° of hardness indicates the presence of calcium and magnesium compounds (and other soap-destroying compounds) in an amount equivalent to 1 grain of calcium carbonate (CaCO_3) per United States gallon. Hardness is now more often expressed as parts of the above compounds, calculated to calcium carbonate, per million parts of water. (One grain per United States gallon = 17.12 parts per million.) Hardness is of two kinds, as follows:

(a) **TEMPORARY HARDNESS.**—Hardness caused by the bicarbonates of calcium and magnesium is known as temporary or carbonate hardness. Other elements, such as iron, aluminum, strontium, or barium, also would cause hardness, but these are not found in the water of public supplies in quantities large enough to have any appreciable effect. Nearly all of the temporary hardness can be removed from water by the simple process of boiling, carbon dioxide being expelled

and the normal carbonates of the elements which cause "hardness" being precipitated. Temporary hardness can also be removed by the addition of limewater or slaked lime, but the boiling method is preferable in the household. The chemicals generally used in household washing to reduce or remove hardness are trisodium phosphate, sodium carbonate (soda ash), washing soda (laundry soda), borax, and ammonia. One or more of the first four of these or sodium silicate is frequently incorporated as a "builder" in soaps to act as water softeners and detergent aids.

(b) PERMANENT HARDNESS.—Hardness caused by all other compounds of calcium and magnesium, generally sulfates, chlorides, and nitrates, is known as permanent or noncarbonate hardness. Permanent hardness is not affected merely by boiling, but can be removed from water either by chemical treatment or by distillation.

3. WATER IN LAUNDERING

It is obvious that soft water, free from iron, suspended matter, and oil, is to be preferred for laundering operations. Salts of calcium, magnesium, iron, and other heavy metals not only render a portion of the soap ineffective as a detergent, but form additional material to be emulsified by the remaining soluble alkali metal soap (soda or potash soap). Some of the insoluble calcium and magnesium soaps are deposited in the fabric and may not be completely eliminated in the suds bath. In the rinsing bath most of the insoluble soap, together with some of the suspended dirt, may be deposited on the fabric. When precipitated uniformly on fabrics, this produces gray, dingy work or "grayness" that is not corrected by bleaching. When deposited in spots or globules, it produces the so-called soap specks or grease specks. Iron causes yellowed work. This may be corrected by the use of oxalic acid or other iron solvent, followed by thorough rinsing with water to remove all traces of the reagent used, but the proper procedure is to remove the iron compounds from the water before use. Sulfides in water may cause stains, especially with iron. When the use of a sulfide water cannot be avoided, it should be treated with an oxidizing agent, such as "hypochlorite bleach," to convert the sulfides into sulfates, and should be kept alkaline in every operation prior to souring and rinsing.

The value of softened water is indicated in the studies made by various investigators. Whipple¹ found that water with less than 20 parts per million of hardness consumed relatively more soap than water of higher hardness. For example, about 6 lb of soap was required to soften 1,000 gal of water of 20 parts hardness and 22.2 lb for a hardness of 100. Robbins, MacMillan, and Bosart² reported that about 10.4 oz of soap was required to soften 100 gal of water of 77 parts per million of hardness, and 30.4 oz of soap was required when the hardness was 238 parts per million. Hudson³ has made a field survey of the retail sales and consumption of soap in four cities of the middle west with different types of water. His figures indicate that soap consumption is roughly directly proportional to water hardness and show an annual per capita consumption close to 50 lb in

¹ G. C. Whipple, *The Value of Pure Water* (John Wiley and Sons, New York, N. Y., 1907).

² H. B. Robbins, H. J. MacMillan, and L. W. Bosart, *Amounts of soap and builder necessary to soften water of different degrees of hardness*, Ind. Eng. Chem. 18, 27-29 (1926).

³ H. W. Hudson, *Soap consumption in hard water districts*, Water Works Engineering (January 1934).

districts with very hard water, scaling down to about 29 lb in districts with moderately hard water. Using Whipple's tables, Foulk ⁴ has derived the following equation, in which H equals the total hardness of the water in parts per million:

$$\text{Pounds of soap consumed per 1,000 gal} = 2 + 0.2 H$$

In addition to the effects noted above, the compounds which cause hardness also cause the scale which deposits in boilers and pipes. On the other hand, soft waters are generally more corrosive than hard waters and are more likely to cause corrosion or pitting and leaks in steam and water pipes. The rusting of iron or steel piping, especially hot-water lines, is often manifested by the red color that appears in water. This color is due to finely divided hydrated iron oxide. This so-called red water has caused some power laundries much concern. The researches of Russell ⁵ and his colleagues have resulted in the development of a commercial process for the elimination of this trouble by the use of sodium silicate to form protective films in the pipes.

Collins, Lamar, and Lohr ⁶ have reported the hardness of the public water supplies of 670 places in this country and have prepared a map showing in a rough, general way the distribution of hard water in the United States. The map is based on the weighted averages for the different States, calculated from the actual results found. The public water supplies have been grouped, according to hardness, as follows: (a) From 1 to 60 parts per million, generally considered soft. "In ordinary household use hardness below 60 parts per million is scarcely noticed. For supplies with hardness nearly up to 60, softening is profitable for laundries, for many steam-boiler plants, and for a few other industrial uses." (b) From 61 to 120 parts per million. "Those who are accustomed to really soft water will notice the hardness of supplies in this range, especially in the upper part. To those who have regularly used water with hardness of several hundred parts per million, the hardest of this group will seem soft. Household water softeners have been installed by some users of supplies with hardness near the upper limit for this group. Softening of any supply in this group is likely to be profitable for a laundry, and softening or treatment within the boiler is necessary for a steam-boiler plant." (c) From 121 to 180 parts per million. "Nearly everyone notices hardness in this range, yet many supplies, especially those nearer the lower limit, cause little complaint when used without softening. Household softening is commonly found desirable by those using supplies that fall within this range of hardness. Any industrial plant in which hardness is detrimental will soften water whose hardness falls within the range for this group." (d) More than 180 parts per million. "Water with hardness greater than 180 parts per million is considered really hard. It is necessary to soften such water for laundry use or for use in steam boilers. Some of the supplies of very hard water in this group would be unsatisfactory for some uses even after softening."

⁴ C. W. Foulk, Industrial Water Supplies of Ohio, Geological Survey of Ohio, Bulletin 29 (1925); *The value of softened water*, Ind. Eng. Chem., News Ed. (Aug. 20, 1924).

⁵ R. P. Russell, *Rust prevention in laundries*, Starchroom Laundry J. (Dec. 15, 1923).

⁶ F. N. Speller, *Corrosion—Causes and Prevention* (McGraw-Hill Book Co., Inc., New York, N. Y., 1935).

⁶ W. D. Collins, W. L. Lamar, and E. W. Lohr, The Industrial Utility of Public Water Supplies in the United States (1932); U. S. Geological Survey Water-Supply Paper 658, p. 12-19 (1934).

Regarding the use of water in power laundry operations, the department of research of the Laundryowners' National Association has stated:

The main factor, from a laundering viewpoint, is that of quality. Even when using water containing as little as 2 grains of hardness it has been observed that a better grade of white work is secured if the water is softened. In view of this fact, it is interesting to note that many laundries that use such waters without softening them are now running the first rinse at a low suds level rather than at the customary higher rinse levels. By so doing there is less tendency for insoluble soap deposits to be thrown out of suspension in the early rinses since a smaller quantity of hardening constituents is added at the lower level. The following rinses are run at the usual high levels. This much is certain, the quality of the washing is improved when water containing 2 or more grains of hardness per United States gallon is softened. The savings with regard to supplies naturally will be less noticeable than is true when the raw water contains 4 or more grains of hardness.

Many public water supplies have up to 100 parts per million (about 5.8 grains) of hardness per gallon. Satisfactory home laundering can be done in such water by adding softening chemicals (soda ash, trisodium phosphate, borax, etc.) to the heated water at least 1 minute before using soap, or using a "built" or "builted" soap (which contains such materials). When soap and builder are added together, the cost of water softening is said to be practically the same regardless of the proportions of soap and builder in the mixture used. It is therefore better to add the builder first.

During the past few years, the newer detergents or "soap substitutes," which are sodium salts of the alkyl sulfates and sulfonates, have become commercially available. As the calcium and magnesium salts of these fatty alcohol compounds are fairly soluble, these detergents may be used in most hard waters without appreciable precipitation. Owing to the cost of these nonsaponaceous detergents at this time, soaps, both with and without alkaline salts, and alkaline salts alone, are still considered more economical and satisfactory for general washing purposes, if their continued extensive use is a criterion. (See p. 26.) A special sodium metaphosphate, sodium "tetraphosphate," and tetrasodium pyrophosphate are also used in mixtures with various alkaline salts and soap. These phosphates form soluble complexes or compounds with calcium and magnesium, and detergents containing one or more of them are being widely used with hard waters. (See p. 28.)

Water is low in cost, is a good solvent, is practically inert with respect to textile fibers, and is a cleansing agent itself. As already explained, soap and other detergents lower the surface tension of water, and thus increase its cleansing action.

Perfectly pure water can be obtained only by distillation. Rain water, when carefully collected, is the purest water ordinarily obtainable for the household, and is especially useful when very soft water is desired.

4. WATER SOFTENING

Water softening is usually effected by the "zeolite" process, or by the soda-lime process (hydrated lime and soda ash), or some modification of it. The zeolite process is in use in many households. These processes are described in publications on water treatment and therefore will not be described here.

The zeolite process is in general use in the laundry industry, although with certain waters the lime-soda process may be preferred; for example, with muddy waters, waters high in iron, carbonic acid, or other acid. In such cases it would be advantageous to pass the filtered, partially softened water through a zeolite softener. When waters high in temporary or carbonate hardness are passed directly through a zeolite softener, the concentration of sodium bicarbonate in the effluent may prove a disadvantage in "souring" and bluing. Rinsing in water high in sodium bicarbonate may cause trouble by the conversion of the sodium bicarbonate retained in the goods into sodium carbonate on drying and ironing. This can be overcome by adding a little acetic acid in the last rinse. The zeolite softener when properly operated delivers water of nearly zero hardness; this cannot be attained with the lime-soda process. With very hard waters and waters high in temporary hardness a preliminary softening is often made by the lime-soda process and the resulting partially softened water filtered and then completely softened by the zeolite process, or used with one of the newer detergents mentioned above.

5. DISSOLVED IMPURITIES OTHER THAN HARDNESS

As stated above, some waters contain compounds of iron and sulfides in appreciable quantities. All natural waters contain dissolved gases, organisms, and various salts that do not precipitate soap. Iron, sulfides, manganese, and the salts which cause hardness, referred to above, are generally the compounds to be taken into account in considering a water supply for laundering operations. Waters high in alkalinity caused by the presence of alkaline sodium compounds are sometimes used, the alkalinity being corrected by a sour in the final rinse water. (See "winter damage," p. 30.) Waters containing free acid may be neutralized with a little soda ash, a precaution that is absolutely essential if corrosion of piping, heaters, and boilers is to be avoided.

IV. SOAP

1. GENERAL COMPOSITION OF SOAP

All metallic salts of the higher fatty acids are, strictly speaking, soaps; but the fatty-acid salts of the alkali metals and of certain organic bases such as triethanolamine are the only ones that are soluble in water, and therefore the only ones commonly used as cleansers in aqueous solutions. Water-soluble soap is also used in the preparation of numerous toilet articles, cosmetics, and pharmaceutical products. Probably its most important function in such preparations is as an emulsifying agent; however, its detergent action is also important. The consistency of many creams, pastes, or salves may be due to the tendency of the soap in them to form jellies. Soap is also used as a vehicle for carrying various materials in the form of cream or paste. Soaps of some of the other metals are used for particular purposes, such as aluminum soaps, which are used for thickening lubricating oils and in waterproofing concrete and other materials; iron and chromium soaps, which are used in dyeing and color printing; lead, manganese and cobalt soaps, which are used as "driers" in paints and varnishes; lime soaps and lead soaps, which are used in the preparation of adhesive plasters; lime soaps, which are used in the

preparation of lubricating greases; zinc and magnesium stearates, which are used in dusting and talcum powders and in rubber compounding; and magnesium oleate, which has been used in solution in dry-cleaning solvents, such as gasoline or other inflammable petroleum distillate, to prevent or reduce the fire hazard due to static electricity. These, however, are used for purposes so radically different from those which call for the detergent soaps that they will not be considered in this circular.

In addition to alkali salts of fatty acids and sometimes rosin and naphthenic acids (obtained from petroleum), all soaps contain some water and small amounts of impurities and byproducts of manufacture. For various purposes certain other substances ("builders") frequently enter into the composition of commercial soaps. Among building substances may be mentioned sodium carbonate, borate, silicate, and phosphate for hardening soaps and for improving their cleansing action when used with hard water; sand, volcanic ash, infusorial earth, pumice, clay, starch, and like substances intended to aid mechanically in the process of cleaning; glycerol (glycerin), for increasing the emollient properties; sugar, alcohol, and glycerol, for increasing transparency in solid soaps and for preventing clouding and foaming in liquid soaps; colors and perfumes in many varieties. Certain colloidal clays, colloidal silicates, and colloidal organic materials are sometimes added to soaps and cleaning powders to serve both as detergents and as mechanical aids in cleaning operations. Certain other materials, such as mineral oils, waxes, talc, starch, ground wood, etc., are sometimes used for specific purposes, but when added for the express purpose of cheapening the soap they should be regarded as fillers.

For toilet use or for washing delicate fabrics in rain water or other very soft water a soap should be used with little or no builders; but with hard waters these builders prevent waste and increase the efficiency of the soap by acting as water-softening agents and detergent aids. When washing greasy or badly soiled fabrics in soft water, these builders increase the efficiency of the soap. However, for maximum economy where hard water must be used, it is best to add a softening agent to the heated water, stir and let stand a while to react before adding soap, even soap containing material intended to soften the water. In all cases the builders tend to increase the cleansing properties of the soap. Certain materials are often added for special purposes. For example, so-called naphtha soap contains a special petroleum distillate; pine scrub soaps contain pine oil; pumice soap contains finely ground pumice and is used very extensively by mechanics for removing oil and stains from the hands; certain soaps contain special solvents, such as ethylene chloride, hydrogenated phenols, hydrogenated naphthalenes, etc. Triethanolamine soaps are used in water solutions for washing linoleum and composition floorings, as a detergent in dry-cleaning solvents, and as emulsifying agents. Ammonium soaps are used as detergents and emulsifying agents.

Such substances as sulfur, carbolic acid, and mercury salts are added to medicinal soaps; tobacco extract, pyridine, etc., are added to insecticidal soaps; perborates and peroxides are added to some soaps and soap powders. These special soaps, however, will not be considered.

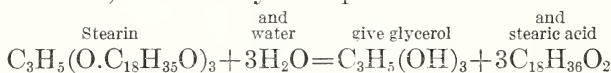
Animal and vegetable fats and oils are mixed esters, or more specifically, mixed glycerides of the higher fatty acids, and it is from these materials that soaps in general are made. The difference between a fat and an oil is mainly physical. The term "fat" is generally applied to those glycerides which are solid at ordinary temperatures and "oil" to those which are liquid under similar conditions. For the sake of simplicity we will use the term "fat" to cover both classes. Each fat as found in nature contains the glycerides of several different fatty acids, the principal ones being named, stearic, palmitic, and oleic acids. These occur in varying quantities in practically all fats, the solid fats containing a large proportion of stearic-acid glyceride (stearin); the liquid fats a large proportion of oleic-acid glyceride (olein). There are a large number of fatty-acid glycerides besides the three mentioned above which occur in certain fats, such as lauric-acid glyceride (laurin) in coconut and palm-kernel oils, myristic-acid glyceride (myristin) in palm-kernel oil, linoleic-acid glyceride (linolein) in linseed oil.

The development of the hydrogenation process has given the soap-maker a cheaper source of fats in that it enables him to employ a number of oils which otherwise would be of limited use to him. By this process the oils (liquid fats) are hardened and deodorized, mainly by more or less complete conversion of the olein into stearin. Fish oil, train oil, cottonseed oil, soybean oil, and other oils are hardened and the hardened fats used in soapmaking. These hardened fats are mixed with suitable amounts of other fats to give the desirable qualities (lathering, etc.) to the soaps.

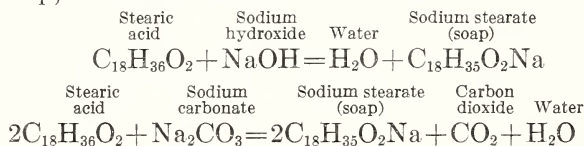
The numerous animal and vegetable fats, such as tallow, lard, olive oil, palm oil, coconut oil, cottonseed oil, and soybean oil are neutral substances which may be decomposed by the aid of superheated steam (autoclave saponification) or other suitable means into two separate portions, namely, a mixture of fatty acids, on the one hand, and glycerol, on the other.

Probably the most widely used method for splitting fats into fatty acids and glycerol is the Twitchell process or some modification of it. In these processes the fat is boiled with water and the proper amount of a special organic reagent known as the "saponifier." The special reagent acts as a catalyzer, that is, accelerates the saponification, or splitting, by the water. Under specially controlled conditions, the mixed fatty acids may be fractionally distilled in order to separate them for the manufacture of soaps and other products.

Saponification is the term applied to this splitting of an ester by the action of water, forming an alcohol and a fatty acid (glycerol is the alcohol in fats). This may be expressed as follows:

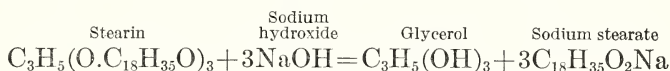


The stearic acid can be neutralized by caustic or carbonated alkali, forming soap, as follows:



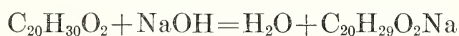
The same types of reaction take place with other free fatty acids.

It is not necessary to split the fats into glycerol and fatty acid previous to neutralizing the acid with alkali. In fact, one of the most important and one of the oldest methods in use is to treat the fat itself with caustic alkali in the presence of water, the reaction being represented by the equation



The same type of reaction occurs with all other fats. Mineral and essential oils are not fats and with few exceptions they do not contain fatty acids. Waxes are not glycerides, but do contain fatty acids in combination with alcohols of high molecular weight. They can be saponified in the same manner as fats, but are seldom used in this manner.

Rosin (colophony) is an acid substance, and while its exact nature is not as well understood as that of the fats it may be tentatively considered to be mainly abietic acid ($\text{C}_{20}\text{H}_{30}\text{O}_2$), which reacts with alkali according to the equation



Certain acidic substances obtained in the refining of some petroleum and known as naphthenic acids are used for the production of naphthenic soaps by neutralizing the acids with alkali.

Hard soaps are generally made with soda, while the potash soaps are soft and are more easily soluble in water than the soda soaps. The character of the fatty materials used and the method of manufacture also influence the hardness, solubility, appearance and other properties of the resulting soaps, the hard fats, such as tallow, and hydrogenated or "hardened" fats, making harder soaps generally than the more fluid fats. Rosin makes soaps softer, and it can therefore be used best in connection with tallow and other hard fats. Coconut oil and palm-kernel oil make hard soaps that dissolve very readily in water; hence lather freely. Soap made from straight coconut oil or palm-kernel oil is said to be irritating to the skin of some people. However, it has been claimed that when superfatted such soaps are mild, and that when properly made they have no tendency to become rancid or develop acidity. Soap made from straight palm-kernel oil may develop acidity. Palm oil when used alone as the fat stock may produce a "crumbly" soap. Cottonseed oil, corn oil, soybean oil, linseed oil, etc., also impart certain characteristics to soaps made from them. Olive oil is used largely in the manufacture of textile soaps; mixed with tallow and coconut oil, it is used in the manufacture of milled toilet soaps; it is also used in the manufacture of Castile soap. Red oil (oleic acid) is now used extensively to replace olive oil, especially in textile soaps.

2. METHODS OF MANUFACTURE

The method most generally used for the manufacture of a sodium soap is the graining or boiling and settling ("full-boiled") process. This method of making soap requires close attention and control. The fatty stock, concentration of alkali solutions, temperature, amount of salt used, time of settling, etc., are all influencing factors. The neutral fats are melted, the impurities allowed to settle, and the

clear fats run or pumped into the soap kettles and heated with an open steam coil. A 10- to 15-percent solution of caustic soda (the lye drawn off as the "strong" change from a previous batch of soap may be used) is gradually added and the mixture heated by steam until the saponification is about 90 to 95 percent complete. Salt is then added until the soap is "grained" or salted out of solution and floats on top as a curdy mass. The steam is turned off, and the salt solution, containing glycerol, alkali, and impurities, settles to the bottom. When properly settled, the salt solution is drawn off as the first "spent lye change." The soap is then thinned out by adding water and sufficient caustic-soda solution to give it a slightly alkaline reaction after being thoroughly boiled. Salt is again added and the soap grained from the lye. When properly settled, the lye is drawn off as the "second lye change." This process is repeated until the fat is completely saponified and the glycerol and impurities are washed out of the soap. These lye changes are used for the recovery of the salt and glycerol. The soap is then boiled with a 10- to 15-percent solution of caustic soda to insure complete saponification, and, as an alkali solution of this strength "grains" the soap, it is allowed to stand after boiling until the soap separates. The lye is then drawn off as the "strong" or "strengthening change."

The soap is then thinned with water, boiled to a uniform consistency, and allowed to settle. This settling requires from a few hours to several days, depending on the kind of soap being made, and the size of the kettle. The temperature during this settling is so regulated that the soap after delivery to the crutcher will have a temperature of about 130° to 135° F. The salt, alkali, and impurities settle to the bottom of the kettle to form the pitch water and nigre, leaving the soap on top. The soap is then run off from above the nigre and pumped to the "crutcher" or mixer, which consists essentially of a cylindrical steel or iron tank equipped with a worm agitator, and usually steam-jacketed. Alkaline sodium salts or "builders" are added at this stage. Perfumes, colors, and other ingredients required in the completed soap may also be added. The temperature during crutching ranges from 200° F down to 135° F, depending upon the grade of soap and the amount of "builders" added; therefore, there will be a loss of certain perfumes by volatilization. When the "builders" or other added substances are thoroughly incorporated in the soap by crutching, the mixture is run into "frames" to cool and harden. The frames are essentially iron boxes, the four upright movable sides being fastened together and to a platform (called a "frame bottom") on wheels. When the soap has hardened sufficiently (generally about 3 to 7 days), the sides of the frame are removed (called "stripping") and the large solid cake of soap, called the "frame of soap," is cut with wires by hand or by a "slabber" into slabs of any desired size. The "slabber" is a machine with parallel wires at a uniform distance apart. These slabs are then divided into cakes or bars by the "cutting-table," a machine performing two cutting movements at right angles to each other. In nonmilled soaps (laundry soaps, floating soaps, etc.) the cakes or bars are allowed to dry somewhat in the drying room to form a thin, hard surface film, pressed by automatic presses, and wrapped and packed by machinery.

In making soaps containing rosin, the rosin may be melted with the fats and run into the kettle at the outset, or it may be neutralized

("saponified") separately with sodium carbonate and the rosin soap run into the kettle just before the addition of alkali for the "strong change." Sometimes the rosin itself is added at this stage.

In making toilet and white floating soaps, where a neutral product is desired, the pitch water and nigre are usually drawn off and the settling process is repeated until the desired neutrality is obtained by settling out the excess of alkali.

The soap maker also uses the methods known as the "cold" process, the "half," or "semiboiling" process, and the so-called "carbonate saponification" process. The cold process is the simplest method of soap making and requires the least equipment. However, no separation of soap is effected, the product contains the glycerol and impurities, and the saponification is frequently not completed and yields a product containing free fat which may later produce rancidity, or containing free alkali. The fats used should be as pure as obtainable, and in some cases it might be advisable to bleach them. The water solution of lye (caustic soda or caustic potash) at room temperature is added slowly, with stirring, to the melted fat (temperature about 100° F), and the mixture is allowed to stand for some time in order that the saponification may continue as a result of the heat developed by the chemical reaction. The soap may then be cut into cakes or bars and pressed. The oil and lye solutions are usually crutched until the proper consistency is obtained (for example, until a finger drawn over the surface of the soap leaves only a slight impression). The mixture is dropped into a frame and allowed to stand covered for some time. "Builders," etc., may be added during the crutching. The soap is then "slabbed" and cut into cakes or bars. The half, or semiboiling process is similar to the cold process, except that the fats (or fats and rosin) are heated to about 150° F in a jacketed kettle or a crutcher and the lye solution is added slowly, so that the heat of reaction will raise the temperature to about 180° to 200° F. These soaps may also be "builded." In the carbonate saponification process, the fatty acids are neutralized directly by alkali carbonates; however, the neutralization is generally completed with a little sodium hydroxide or potassium hydroxide. The entire neutralization process could, of course, be carried out with caustic alkali. Agitation is usually required in this process, and carbon dioxide is liberated. No glycerol will be "split off" as it has previously been removed in the cleavage of the fats into fatty acids and glycerol by the Twitchell, autoclave saponification, or other process. After obtaining the mixture of soap and alkali, the method of finishing is similar to that of the full-boiled process, but fewer changes and washes are required.

Many variations of the four general methods outlined above have been proposed, such as high-pressure saponification; "vacuum" saponification; higher concentrations of lyes, and the use of dry sodium hydroxide; use of solvents, dispersing agents, or catalyzers to accelerate saponification; use of emulsifying agents; continuous methods of saponification; and electrolytic methods and the addition of other electrolytes to the sodium hydroxide solution. Mention is also made of the Krebitz process, which has been used in Europe. This process is based upon the conversion of the fats or oils into lime soaps, which are transformed into the soda soaps by treatment with sodium carbonate. According to the literature, the soda soap so obtained is not of the best quality, but the glycerol recovery is increased, and

the cost of alkali carbonate is less. Information on these procedures will be found in the patent literature for the past 10 years.

The reference books on soap manufacture give formulas for making various soaps and describe the operations involved and the equipment required. These books, some of which are listed on page 59, also describe the raw materials used, the various processes of saponifying oils or fats, recovery of glycerol, etc.

Soap making is a chemical process that requires careful chemical control and special equipment in order to produce a high grade, completely saponified product containing no free alkali. A competent chemical engineer should be consulted before attempting to make soap on a commercial scale. It is considered more economical to buy ready-made soap than to attempt to manufacture it on a small scale or in a crude way. This is especially true if a high grade of soap is desired. However, directions for making a crude soap for rough cleaning from household grease and caustic soda (lye) will be found on page 25.

The user of soap should bear in mind that there are many varieties of soaps, and what is satisfactory for one purpose may be unsatisfactory or too expensive for another.

V. VARIETIES OF SOAP

1. TOILET SOAPS

Toilet soaps should be neutral, since excess alkali is injurious to the skin. Builders, such as sodium carbonate and sodium silicate, which have a similar effect, should also be absent. Free-lathering soap is generally desirable, and since a soap made from tallow or hardened fats lathers slowly and coconut-oil soap lathers very freely, usually 20 to 30 percent of this oil is mixed with 70 to 80 percent of tallow, palm oil, or hardened fats to produce a soap that will lather freely. Olive oil and potash are frequently used in toilet soaps to produce better lathering qualities.

(a) MILLED TOILET SOAPS are prepared by first obtaining a finely divided (flake or powder), pure, dry soap, adding perfume, if desired, and compressing into cakes. More delicate perfumes can be used with this class of soaps, since the perfume is mixed in the process of milling, than with ordinary soaps in which the perfume is added before the soap is dried.

A common method of manufacturing such soaps consists in running the hot liquid soap from the kettle directly over water-cooled, sometimes brine-chilled rolls, which congeal the soap in a thin film on the rolls. The soap is then scraped off in the form of thin ribbons or flakes which fall on an endless belt and are carried through a drier to reduce the moisture content to 12 to 15 percent. The ribbons or flakes are run into a mixer, called an "amalgamator," and perfume and coloring matter (medicants in the case of medicated soaps) are incorporated by a thorough mixing. The soap is then "milled" by passing it between two or more heavy rolls until it has a smooth finish, and the added materials are uniformly blended or incorporated. The thin ribbons or flakes of soap scraped from the last roll are then "plodded." A "plodder" is a machine in which the flakes are forced under great pressure through a "shaping plate" to give the desired

size and shape. These bars are cut into the desired lengths, which are fed into a press and stamped into cakes. The cake is then ready for wrapping and packing.

Although it is not the common practice today, sometimes a very small amount (about 0.5 to 1 percent) of high-grade titanium dioxide or zinc oxide is carefully added to a white soap during milling to remove any translucency that may be caused by "plodding." It has been claimed that these compounds would also remove any yellowish cast, but such an effect does not appear probable. Special blue dyes have been used in very small amounts to mask a slight yellow color in such soaps.

Some toilet soaps are put on the market in the powdered form. Powdered starch or powdered talc are sometimes added to prevent caking.

(b) **FLOATING SOAPS** are generally made by the boiling and settling process, except that minute air bubbles are incorporated into the hot soap by a specially constructed crutcher, by crutching at a high rate of speed, or by reversing the direction of the screw several times during the crutching. These air bubbles are so small as to be almost invisible and so numerous that they not only make the cake of soap lighter than water, but also largely increase the surface of the soap exposed to water when used, and, therefore, render it more quickly soluble than the same soap would be without the bubbles.

In the manufacture of these soaps 25 to 30 percent of coconut or palm-kernel oil is used to improve the lathering and detergent qualities of the tallow or hardened fats. Other fats, such as white grease or lard, may be mixed with these.

(c) **CASTILE SOAP.**—One of the first, if not the first, hard cake soaps that entered largely into commerce was made from pure olive oil and soda with no admixture of any other fat. Such a soap was known as Castile, Marseilles, or Venetian soap. Modern trade practices and manufacturing methods had so altered the accepted meaning of the term "castile" as to result in a ruling in 1932 by a Federal court that a product labeled or sold as "castile soap" may contain oils and fats other than olive oil. There are soaps made entirely from coconut oil which are sold as coconut castiles or hard-water castiles. Other castiles are made from a mixture of coconut oil and tallow or other fat. When made from olive oil, it is sold as olive-oil castile. Castile soap for toilet or household use is usually sold in unwrapped, unperfumed bars and in small cakes or bars both wrapped and unwrapped. It is generally made by the full-boiled process and is often drawn directly from the kettle without "crutching," but is sometimes crutched a little, or even enough to make it float, and is sometimes milled. There are also on the market powdered castile soaps and "liquid castile soaps." The latter are intended for hospital use and are water solutions of potash soap, generally made wholly from olive oil, or a mixture of olive oil with about 10 to 20 percent of coconut oil and potash.

(d) **TRANSPARENT SOAPS** were originally made by dissolving soap in alcohol, filtering, and evaporating most of the alcohol. This procedure has been practically discarded because of the expense. Transparency is generally due to the presence of alcohol, glycerol, or sugar in the soap. Rosin has been used in making such soaps. The mate-

rials used in making transparent soaps should be carefully selected for purity and color, especially when clearness and lightness of color are desired in the finished product. The sugar, alcohol, or glycerol is usually added during the crutching. Transparency formerly was considered an indication of freedom from impurities, but is actually no indication whatever of purity or quality.

(e) LIQUID TOILET SOAPS are water solutions, generally of a neutral coconut-oil potash soap, and may contain glycerol, sugar, or alcohol added to lower the freezing point and to prevent cloudiness and foaming in the container. Sometimes the coconut oil is replaced in part by palm-kernel oil or other vegetable oil, such as olive oil. The glycerol is probably an unobjectionable addition, since it has emollient properties, but sugar can have no beneficial action on the soap itself and may be objected to because it tends to leave the hands sticky. The oil is run into a jacketed kettle equipped with a stirring device, heated to about 125° F, and the proper amount of a water solution of caustic potash (potash lye) added. After the saponification is complete, the other ingredients (glycerol, alcohol, etc.) are added, the desired volume of water is run in, and the mixture stirred until the soap is dissolved. Color or perfume is stirred in after the solution has cooled. Most of the liquid soaps are chilled to at least 60° F, and preferably lower, and filtered before packing to remove the unsightly, slimy precipitate of partially hydrolyzed soap which is the result of dilution. As a rule, it is best to hold the liquid soap in storage for some days before filtering, in order that the finely divided colloidal particles may agglomerate to a size sufficient to be retained by the filtering medium. Otherwise the solution may not stay clear and bright. Filter aids such as activated carbon and fuller's earth are said to be helpful in giving clarity and brilliancy to the finished soap.

Liquid soap as generally used contains about 12 to 20 percent of anhydrous soap. The soap manufacturers also put out a concentrated liquid soap containing from 40 to 50 percent of anhydrous soap, and a pasty soap known as "liquid soap base." The latter can be mixed with distilled water and glycerol or alcohol to yield a liquid soap with the desired content of anhydrous soap.

(f) SHAVING SOAPS must possess not only the properties of first-class toilet soaps, but must furnish a very copious lather, which will remain on the face for some time without drying. This lather should soften the beard without injuring the skin. These soaps should have no unpleasant odor, and usually they contain little or no perfume.

The fat used in making shaving sticks and cakes or bars generally consists of a mixture of tallow, stearic acid, and coconut oil. The alkali is usually a mixture of caustic soda and caustic potash. Glycerol is also generally present. Sometimes a small quantity of a gum, such as gum tragacanth, is crutched in to aid in holding the lather.

Shaving powder may be produced by thoroughly drying the above soap and then grinding or pulverizing. However, it is generally made according to a separate formula in which more caustic soda and less caustic potash are used. During the pulverizing operation, about 25 to 50 percent of dry tallow soap chips is sometimes added. From 3 to 5 percent of talc is sometimes mixed in to prevent the powder from caking.

Shaving creams (lather creams or brush-type) are usually made by saponifying a mixture of stearic acid and coconut oil (and also tallow in some cases) with a lye made up in the proportion of about five parts of caustic potash to one part of caustic soda. These creams are generally perfumed and frequently contain an excess of unsaponified stearic acid, that is, they are superfatted. Castor oil and lanolin have also been used. Added water and glycerol are generally present. Gums or other colloids have also been added.

Liquid shaving soap may be made by dissolving about 6 parts by weight of shaving cream in a mixture of about 6 parts by weight of water and 1 part by weight of alcohol, and adding perfume. To retard or prevent the settling out of the soap, the water may be emulsified with the perfume and a small amount of a vegetable oil, such as olive oil, by the use of triethanolamine stearate or other suitable emulsifying agent. The addition of fatty alcohol sulfates is said to improve liquid shaving soaps.

Brushless shaving creams (latherless type cream) consist essentially of so-called vanishing creams to which have been added various materials. Brushless shaving creams may be made with stearic acid, caustic potash, glycerol, mineral oil or vegetable oil and water, and then perfumed. There are many variations of this general mixture. For example, triethanolamine may be substituted for the caustic potash, and the glycerol may be replaced in whole or in part by other compounds, such as diethylene glycol monoethyl ether ("Carbitol"). Lanolin has also been used in preparing these products.

(g) **TAR SOAPS** are made by mixing 5 to 20 percent of tar, generally pine tar, with a soap base. A small amount of aniline black or lamp-black is often added as coloring matter. Coconut oil frequently forms a part of the fat base to increase the lathering property.

(h) **HAND GRIT SOAPS** are often called pumice or sand soaps and are marketed in the cake, paste, and powder forms. The cake soaps are generally made by crutching a very fine abrasive (usually pumice or "silver" sand) into a cold-made or semiboiled soap made from coconut oil or palm-kernel oil, or a mixture of these oils with tallow or other fat. After the soap is "set," it is slabbed, cut into cakes, dried slightly, pressed, and packed.

The paste soap is generally known as grit paste soap, mechanic's hand soap, and sand soap. It may be made by dissolving the soap base in two or three times its weight of hot water and mixing in the desired amount of the abrasive. Glycerol is generally added to keep the paste soft. The pastes may also contain an added solvent for grease. Sometimes these products are colored, usually pink or blue. They may also be made by crutching the abrasive, glycerol, etc., directly into a potash or potash-soda (soft) soap.

Powdered hand grit soaps are generally mixtures of powdered soap (about 10 to 25 percent), abrasive, and alkaline salts (generally about 2 to 5 percent), such as borax, soda ash, trisodium phosphate, and sodium metasilicate. These soaps are frequently perfumed. The abrasive may be pumice, soapstone (talc or pyrophyllite), silica, sawdust, meal or other starchy material.

(i) **HAIR SOAPS OR SHAMPOOS** are available in liquid, cake, powder, and cream forms. The liquid form is the most widely used soap shampoo at this time, and generally consists of an aqueous solution of potash-coconut oil soap, potash-olive oil soap, or a mixture of these

soaps. Sometimes soaps made from other oils may also be present, such as potash-castor oil soap. These products are generally perfumed and are often colored. Sometimes a little borax, potassium carbonate, or other alkaline salt is added to act as a partial water softener.

The cake soap may be a cold-process soda-coconut oil soap, or it may have as a base a milled toilet soap made from coconut oil and tallow, or a transparent soap. Pine tar, perfumes, and other materials are often added. Powdered shampoo soaps are mixtures of finely powdered coconut oil or tallow-coconut oil soaps with various other substances, such as borax, sodium bicarbonate, and agents claimed to act as medicaments.

Cream shampoos are generally potash soap pastes and may vary from products resembling a shaving cream to a fairly transparent jelly. Pine tar, glycerol, and other materials are often added.

Soapless shampoos contain no true soap. They may be made with a sulfonated fatty oil base, such as a mixture of sulfonated olive oil and sulfonated castor oil. Perfumes, glycerol, and other materials are generally present. Dilute alcoholic solutions, colored and perfumed, of the sulfated fatty alcohols, such as sodium lauryl sulfate or the triethanolamine salt of lauryl sulfate, are widely used as soapless shampoos. These latter products are covered by patents. It has been reported that another type of soapless shampoo consists of a 5- to 10-percent solution of potassium carbonate, mixed with an equal volume of alcohol and perfumed.

2. SALT-WATER OR MARINE SOAP

Soap for use with salt water is made from pure coconut oil, pure palm-kernel oil, or a mixture thereof and the necessary alkali, generally caustic soda. These soaps usually contain alkaline builders such as silicate of soda and soda ash. The Federal Specification for salt-water soap requires definite amounts of sodium carbonate and sodium chloride (salt). Such soaps are less easily precipitated by salt water than soaps made from other fats. Although such soaps may be made by the "semiboiling" process, they are usually made by the "full-boiling" process (or some modification of it) in order to recover the glycerol.

3. LAUNDRY OR COMMON SOAPS

(a) LAUNDRY BAR OR CAKE SOAP is used in large quantities in the household. Ordinary laundry soap is generally made of caustic soda and tallow, with some rosin. The tallow is frequently replaced partly or wholly by grease, cottonseed, coconut, and palm-kernel oils or hydrogenated fish and vegetable oils. Rosin is added to increase the lathering qualities of the soap and is an aid in this respect when used in an amount not greater than one-third of the total fat. Large amounts tend to make the soap sticky and too soluble and to harden the fabric washed with it. Sodium carbonate is added to the soap to increase its water-softening and detergent properties if it is to be used with hard waters.

Sodium silicate is also added to increase the detergent and water-softening properties, especially of soaps which contain 20 to 30 percent of coconut oil and are intended for use in hard-water districts.

Borax and trisodium phosphate have similar action to sodium carbonate and sodium silicate.

These soaps are usually made by the boiling and settling process ("full-boiling"), although other processes may be used.

(b) **HARD-WATER SOAPS (WHITE LAUNDRY SOAPS).**—In order to supply soaps that will lather freely in hard waters, the soap manufacturers have increased the alkaline builders and substituted coconut oil for rosin in the yellow laundry soaps, producing the so-called white laundry soaps. The alkaline builders are usually added in the crystallized form; that is, they are in solution in what is equivalent to their water of crystallization and when allowed to cool will crystallize in the soap to a solid state. These builders often contain about 35 percent of the alkaline salt and 65 percent of water of crystallization. The addition of these alkaline builders in increased quantities to domestic or household laundry soaps has increased the water content of these soaps. The pure soaps free from builders contain 28 to 30 percent of moisture, while the yellow laundry soaps when built contain 36 to 38 percent of moisture, and the white laundry soaps 38 to 42 percent of moisture.

Besides the white laundry soaps there are others made from coconut or palm-kernel oils by the cold process with little or no admixture of alkaline salts ("builders") and usually superfatted, that are used extensively in hard-water districts.

(c) **SOAP CHIPS, SOAP FLAKES, GRANULAR SOAPS, SOAP BEADS.**—Laundry bar or cake soap has been replaced in a large measure by soap in chip, granular, flake, and bead form for household uses. These soaps are generally made from tallow, greases, or hydrogenated fish or vegetable oils combined with caustic soda. Chip soaps are sold as "polished" chips, pure chips, and builded chips. Chip and flake soaps are made by running the liquid soap made by the "full-boiled" process over cooling rolls, which reduce the soap to thin ribbons. These ribbons are passed through driers, which lower the moisture content to not over 10 percent, after which the soap is run through rolls, which reduce it to thin flakes or chips. In making granular soaps, the semiliquid hot soap is forced from a nozzle in a stream; this stream is changed into granules (droplets) by a rapidly revolving blade at the end of the nozzle. The granules are then dropped through a counterblast of hot dry air, which dries them to the desired moisture content. Soap beads are made by a patented process which consists in spraying the liquid soap through a specially constructed nozzle and allowing the granules to fall through a specially constructed vacuum chamber. This process changes the granules to beads, which are much lighter and "spongier" than the granules. Modern laundry practice frequently demands a soap that will dissolve quickly when added directly to the wash wheel instead of being made, as was formerly the case, into a stock solution by dissolving definite amounts of the soap and alkali in a definite volume of water.

The soaps covered by this section should be free from objectionable odor and should rinse readily from fabrics. At the present time, the Federal Specification for this type of soap does not permit the use of rosin.

(d) **POWDERED SOAPS FOR LAUNDRY USE.**—(1) The straight powdered soap is made of the same materials and in the same way as the chip soaps, except that the soap is dried more thoroughly and

is then run through disintegrators which pulverize it to a fine powder. These soaps generally contain not over 5 to 6 percent of moisture and about 88 to 90 percent of anhydrous soap, the remainder being soda ash or other alkaline salt and a very small amount of sodium chloride incident to manufacture. (2) Built powdered soaps are also used in power-laundry practice where the presence of alkaline salts is desired. These soaps vary widely in the proportions of soap and builder; however, some specifications require not less than 50 percent of anhydrous soap, not over 40 percent of builder (soda ash or other alkaline salt), with the sum of the two not less than 75 percent. These products are available for low-, medium-, and high-temperature washing, the type depending upon the fatty stock used in making the soap.

These soaps are often sold as soap powders or washing compounds and may be made by the processes used in the manufacture of ordinary soap powders. However, in this publication the term "soap powder," as distinguished from "powdered soap," is limited to mixtures in which the soap is the minor ingredient.

4. SOAP POWDERS

Soap powders, sometimes called washing powders (not to be confused with "powdered soap" just mentioned), should be entirely soluble in water and should consist of a uniform mixture of soap and sodium carbonate, or other builders in powdered form. Soap powders usually contain 15 to 20 percent of anhydrous soap and the balance of crystallized sodium carbonate, often with the addition of borax, trisodium phosphate, etc. Many manufacturers incorporate a definite amount of an "inhibitor," such as a silicate of soda, to retard or prevent attack of aluminumware by the alkaline salts (sodium carbonate or other builders). There are also soap powders or washing powders containing a bleaching agent in the form of sodium perborate; these products are often called "oxygenated soap powders." Soap powders are used very extensively for general household work owing to their ease of application, solubility, and cleansing qualities.

There are several methods of manufacturing soap powder, but the one generally used is known as the "continuous process." The soap is run hot from the kettle into a crutcher or mixer and mixed thoroughly with a concentrated solution of sodium carbonate (soda ash) or other builders. The mixture is run over chilling rolls to chill the soap and crystallize the sodium carbonate. The product is scraped off the rolls and screened, the coarse particles going to a grinder and the finer portion being packed by machinery. These powders are also made by dissolving soap and sal soda or soda ash in water and spraying or "atomizing" the solution, which gives a product that only requires screening to remove larger particles. As these powders contain a high percentage of combined water (forming a part of the crystallized sodium carbonate), they are usually wrapped in paraffin paper to prevent loss of this water with a corresponding reduction in weight.

5. SCOURING POWDERS

A scouring powder usually consists of a uniform mixture of soap powder and an insoluble abrasive. The abrasive is usually powdered

pumice, volcanic ash, quartz, marble, or feldspar. The abrasive is mixed with the soap and sodium carbonate in a special mixer.

6. SCOURING CAKE SOAP

Scouring cakes consist largely of abrasive material, such as siliceous sand, powdered pumice, volcanic ash, feldspar, etc., with a binder of soap, and frequently considerable sodium carbonate.

Since a higher lathering property is generally required of scouring cake soap than of soap powder or scouring powder, coconut oil is often used in whole or in part as the fat base. The fat is saponified with caustic soda in a crutcher, and sodium carbonate solution, a small amount of sodium chloride solution, and the abrasive are added. After mixing thoroughly, the mixture is framed and cut, or run directly into molds and allowed to harden.

7. SOFT SOAPS

Soft soaps are paste soaps made from vegetable oils of "low titer" (those which yield fatty acids of low solidification point), other than coconut oil, and caustic potash or a mixture of caustic soda and caustic potash. The majority of the soft soaps, particularly automobile soaps, have as their basis linseed oil, soya-bean oil, or corn oil, or the fatty acids of these.

As the recovery of glycerol is practically impossible in the manufacture of potash soaps from fats, oleic acid, known as "red oil," often forms a part of the fat base and potassium carbonate a part of the alkali. Automobile soaps frequently contain a small excess of the neutral fat. The United States Pharmacopœia gives a formula for making "U. S. P. Soft Soap."

After standing for some time, especially in cold weather, soft soaps frequently have apparently crystalline areas distributed through them. This behavior, known as "figging," is apparently due to the crystallization of the higher-melting potassium stearate and palmitate from the matrix of potassium oleate or similar low-melting soaps. "Figging" may be induced by the careful addition of caustic soda to the caustic potash used for the saponification, by using some fatty material high in stearin in the fat base, and by other means. Such soaps are often referred to as "fig" soaps.

8. MISCELLANEOUS SOAPS

(a) LIQUID LAUNDRY SOAPS have been used to a limited extent in some power laundries and textile mills. These soaps are generally made from oleic acid (red oil) and potash, or a mixture of soda and potash and contain, besides a large amount of water, various organic solvents, such as ethylene chloride, "hexalin", etc. Sulfonated oils are also used in the manufacture of liquid soaps for certain textile operations.

(b) MOTTLED OR MARBLED SOAPS are made only to a slight extent in this country and probably for export only. These soaps are made by adding coloring matter (ultramarine, ocher, copperas, etc.) to the soap (usually in the crutcher) just before the soap is run into the frames. The coloring matter is not uniformly incorporated, and the mottled appearance is thereby produced.

(c) **HAND SOAPS FOR USE WITHOUT WATER** are soft or paste soaps for removing oil, grease, etc., from the hands where water is not available. They usually consist of a potash soap base with or without a fine abrasive, such as pumice, and contain mineral oil or free or unsaponified fatty oil and a large amount of water. Glycerol may also be present. Some essential oil is generally added as a perfume.

(d) **FLOOR SCRUB SOAPS** are aqueous solutions containing from 10 to 25 percent of anhydrous soap. These soaps often contain pine oil and are then also known as pine scrub soaps. The soap is generally a straight potash soap, although some mixed potash-soda soaps are used. Linseed oil has been widely used in making these soaps, but other oils, such as soybean, corn, sunflower seed, form the basis for many satisfactory scrub soaps. Fatty acids, such as oleic acid (red oil), are also used. It has been reported that rosin is used in some of the cheaper grades of scrub soaps, and that a straight soda-red oil soap has been used as the base for some of these soaps. Sometimes alkaline salts, such as potassium carbonate or trisodium phosphate, are used in formulating these products. Liquid scrub soaps are generally sold in large units for use in office buildings, institutions, etc. Some of these soaps are emulsions containing solvents added for special purposes.

(e) "**NAPHTHA**" SOAPS are sold in the form of yellow or white common bars or cakes and as chips. The special petroleum distillate ("naphtha") used in the manufacture of these soaps is quite volatile and for this reason the distillate is added to the soap base under controlled conditions and in sufficient quantity to allow for loss by evaporation during handling or storage. The Federal Trade Commission requires that in order to be called "Naphtha Soap" or "Naphtha Soap Chips" the product must contain at least 1 percent by weight of the special petroleum distillate (naphtha) at the time it is sold to the consumer.

(f) **SADDLE SOAPS AND HARNESS SOAPS** are used for cleaning saddles, harness, and other leather equipment. Any well-made, neutral soap may be used in washing leather equipment; for example, a neutral soda-tallow soap low in alkaline salts has been used by the War Department as a "leather-equipment soap." A soap made from soda and olive oil soap stock has also been used. Bleached palm oil and rosin have been used in making saddle soaps; sometimes glycerol is added to the charge, and a small amount of beeswax or other wax is generally added to saddle soaps in order to produce a polish and leave a wax film on the surfaces being cleaned.

VI. ALKALINE CLEANSERS

These materials are used directly for cleaning purposes, water softening, and as detergent aids with soap solutions. Most of them are also used for "building" laundry soaps.

1. AMMONIA WATER

Ammonia water is generally used in the home as the so-called household ammonia. These preparations may consist of a solution of ammonia gas in water or of such a solution containing small amounts of soap and sodium carbonate or borax. The latter solutions are often cloudy or turbid. They are sometimes perfumed. These prepara-

tions are frequently used in cleaning glassware and are sometimes added to the water used for washing clothes to aid in water softening and in the removal of soiling matter.

2. "POWDERED AMMONIA"

The so-called powdered ammonia or ammonia in powdered form usually consists of a mixture of an ammonium salt (generally ammonium sulfate; sometimes a mixture of this salt and some ammonium chloride), and sodium carbonate. Sometimes such preparations may contain considerable amounts of sodium chloride, an inert ingredient from the standpoint of detergency. When dissolved in water, the ammonium salts and the sodium carbonate react chemically and liberate ammonia, which is dissolved by the water. These preparations are used for cleansing purposes and as detergent aids in conjunction with soap. They should be entirely soluble in tepid water and free from caustic alkali or inert fillers.

3. BORAX

The borax found on the market is sodium tetraborate with 10 molecules of water of crystallization ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$). Formerly, the borax supply of this country was derived principally from the minerals borax, colemanite, and ulexite. Most of this supply is now obtained from the mineral kernite (also called rasorite) which occurs in large deposits in Kern County, California. Kernite is sodium tetraborate with only 4 molecules of water of crystallization ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$). The material is mined, dissolved in water, the solution filtered to remove clay and the water allowed to evaporate until recrystallization takes place. Owing to the greater content of water of crystallization about 1.4 tons of pure borax can be made from 1 ton of pure kernite. Borax is a mild alkaline salt and is used as a partial softener of very hard water, as a cleansing agent, as a component of soap powders, and as a "builder" in some soaps. It should be entirely soluble in water.

4. SODA ASH

Soda ash is anhydrous sodium carbonate (Na_2CO_3) and is usually found in commerce in three grades, viz, "58-percent ordinary or light," "58-percent extra-light," and "58-percent dense" (about 58 percent of sodium oxide and about 42 percent of carbon dioxide). Chemically, the three grades are identical and perform the same functions. The dense grade is used where small bulk is desirable; for example, in glass manufacture. Soda ash is used as a water softener, soap "builder," detergent aid in laundering, and as a cleanser (bottle washing and dishwashing, metal cleaning, etc.) where a moderately strong alkaline material is desired. It should be entirely soluble in water and free from caustic alkali.

5. LAUNDRY SODA (WASHING SODA)

Laundry soda (washing soda) is a so-called "modified soda" or "neutral soda." Modified sodas are mixtures of varying proportions of sodium carbonate and sodium bicarbonate. The latter insures the absence of caustic alkali. Such sodas are milder alkaline salts than soda ash or straight sodium carbonate. One of the modified

sodas is known in the trade as "sesquicarbonate of soda." These sodas should be completely soluble in water. They are used in laundering and other cleansing operations where a mildly alkaline material is desired.

6. SAL SODA ("WASHING CRYSTALS" OR "SODA CRYSTALS")

Sal soda ("washing crystals" or "soda crystals," also sold as "washing soda") is sodium carbonate combined with 10 molecules of water of crystallization ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$). This compound contains over 60 percent of water, and when the water is expelled by heat or otherwise, the clear crystals disappear, and the material becomes an opaque powder, with a corresponding increase in alkaline strength per pound (complete expulsion of the water converts it into anhydrous sodium carbonate). Sal soda is readily soluble in water and is used as a detergent and water softener.

7. MONOHYDRATE CRYSTALS OR GRANULAR SODIUM CARBONATE

This compound is sodium carbonate with 1 molecule of water of crystallization ($\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$). It is used in cleansing operations (dairies, metal cleaning, etc.).

8. CAUSTIC SODA (LYE) (DRAINPIPE CLEANER)

Caustic soda or sodium hydroxide is marketed in a number of grades varying from about 98 percent of sodium hydroxide (NaOH) to about 78 percent. It is marketed in various forms, as lump, flake, ground, and powdered caustic, and as a concentrated solution. The ground or powdered caustic is said to be quite stable against deliquescence when left in an open container. Ordinary lye or concentrated lye is generally a grade of caustic soda containing from 90 to 95 percent of sodium hydroxide.

Owing to the very corrosive action of caustic soda upon the skin, it should be handled with great care. It is used in certain cleansing operations, soap making, water softening, etc. It is also used, either as such or mixed with aluminum turnings, for cleaning drain pipes. Mixtures of caustic soda, sodium nitrate, and aluminum turnings are also used for this purpose. Such use depends upon its action on the accumulated grease and the insoluble soap curds that may have been formed by the interaction of the grease with the dissolved mineral matter in the water supply, but, infrequently, the soap so formed apparently accumulates more rapidly than it can be dissolved by the water and, hence, increases the stoppage. When water is added to mixtures containing aluminum, this metal and the caustic soda react vigorously, forming a gas. The stirring or agitating effect of this gas may facilitate the removal of waste matter lodged in drain-pipes. The use of the more expensive caustic potash would probably be more satisfactory, as this compound would convert the grease into a soft soap which is more readily dissolved by water. The heat generated on dissolving caustic soda (lye) or caustic potash in water will aid in the saponification of the grease and soap. Caustic soda and caustic potash corrode lead pipes and attack the surface of enameled sinks, etc., and therefore should be kept out of contact with the enamel and not used frequently in lead pipes.

Adequate directions for the domestic preparation of soap from household grease and caustic soda are usually given on the labels on lye containers. For example, such a soap may be made as follows: Carefully add the contents of a can of household lye (containing 13 oz of lye which should be at least 94 percent caustic soda) to an iron kettle containing $3\frac{1}{2}$ pints of cold soft water. Stir until all is dissolved, and allow the solution to cool until it is just lukewarm.

In another vessel melt $5\frac{1}{2}$ lb of clear grease, lard, or tallow, let the melted grease cool until it is just warm to the hand; then pour the solution of lye slowly into the melted grease, stirring the mixture in the meantime. After the lye has been added, stir the mixture for about 10 minutes until it is well and evenly mixed, and then pour it into a suitable mold. Cover and set in a warm place for a day or two; then cut into any desired shape with thin twine or a fine wire.

The grease, lard, or tallow must be clean and free from salt. Care must be taken to stir the lye into the grease, not the grease into the lye. If the soap is streaky, with greasy layers, showing that the fatty matter is not thoroughly combined with the lye, owing to improper stirring, put it into a pan or other vessel with 1 pint of soft water and boil until the soap is melted and clear. Pour into a mold, wrap to keep hot as long as possible, and set aside for 2 or 3 days.

A soap made according to the above procedure should be suitable for rough cleaning or washing operations.

9. SPECIAL ALKALIES

"Special alkalies," also known as "causticized ash," are mixtures of caustic soda and soda ash, and are usually graded in the trade according to the content of actual sodium hydroxide or caustic soda. These products are used in cleansing operations where a strong alkali is needed, or where the bactericidal action of a strongly alkaline solution is necessary (as in a bottle wash).

10. TRISODIUM PHOSPHATE

This orthophosphate has the chemical formula $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$. Technical trisodium phosphate is a white crystalline product and usually contains a small amount of sodium hydroxide or sodium carbonate owing to the process of manufacture. It is sold in the flake (fine crystals), granular, and globular (beads) forms, and sometimes is colored with a dye. This material usually contains about 56 percent of combined water, is readily soluble in water, and is a rather strongly alkaline salt. It is suitable for a variety of cleaning purposes; for example, dishwashing, bottle washing, laundering, and cleaning floors, painted surfaces (in very dilute solutions), many metals, printers' type, dairy equipment, oil tanks, etc. It is also used as a water softener, soap "builder," etc. Many washing powders on the market consist of trisodium phosphate or mixtures of this material with soda ash, borax, soap, and other detergents. Solutions of trisodium phosphate and other alkaline materials will attack aluminum, and, in some cases, tin, zinc, and copper. However, this corrosive action may be markedly reduced or practically prevented by mixing a highly siliceous sodium silicate with these alkaline salts. Davies⁷ has reported that the corrosion of tin can be minimized by the use of 0.5 to 1.0 percent of sodium sulfite in the detergent mixture.

⁷ W. L. Davies, *Detergents in dairy work*, Dairy Inds. 2, 438-439 (1937).

Trisodium phosphate containing one molecule of combined water ($\text{Na}_3\text{PO}_4 \cdot \text{H}_2\text{O}$) is also available. This product is used in mixtures with other alkaline materials where a high content of combined water in the various materials may cause caking and prevent free flowing.

11. SILICATES OF SODA

There are a number of silicates of soda for various uses, the differences being in the ratios of sodium oxide (Na_2O) to silica (SiO_2). Special grades in the solid form and as solutions in water are made for use in the manufacture of soap (a "builder" to serve as a water softener and detergent aid). The solution in water is often known as "water glass." Silicates of soda are used directly as cleaning agents and also in the preparation of mixtures for a variety of cleaning purposes. Sodium metasilicate ($\text{Na}_2\text{SiO}_3 \cdot 5\text{H}_2\text{O}$), owing to its rapid solubility and alkalinity, is widely used in bottle washing, in dishwashing compounds, in most industrial metal cleaning, etc. However, for certain metals (tin, aluminum, zinc, copper), or other surfaces that may be damaged, a more siliceous (less alkaline) silicate should be used, such as a highly siliceous liquid silicate or a powdered hydrous siliceous silicate. Baker⁸ has shown that the protection of a more siliceous silicate, together with the rapid solubility of the metasilicate, can be obtained by preparing a dry mixture of sodium metasilicate and a less alkaline salt or salts, such as monosodium phosphate, disodium phosphate, sodium bicarbonate, or borax.

12. COLLOIDAL CLEANING POWDERS

Several preparations are marketed under this general title. Various materials are used to act as detergents by forming colloidal solutions in water; for example, causticized starch or starchy matter, causticized cellulosic matter, certain colloidal clays, etc. The colloidal matter is mixed with such substances as soda ash, trisodium phosphate, washing soda, borax, and soap. Artificial sodium aluminosilicate is also used as a colloidal cleaner. These materials may be used directly for cleaning purposes, but they are generally used as alkaline assistants or detergent aids in conjunction with soap in laundering operations.

13. POTASSIUM COMPOUNDS

Caustic potash and potassium carbonate are used in the manufacture of soft soaps, liquid soaps, shaving soaps, and dry-cleaning soaps. The cheaper sodium salts are in general use for cleaning.

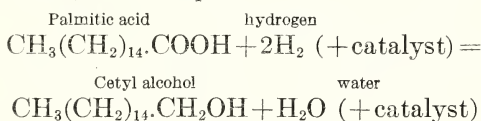
VII. MISCELLANEOUS DETERGENTS AND DETERGENT AIDS

1. FATTY ALCOHOL SULFATES AND SULFONATES

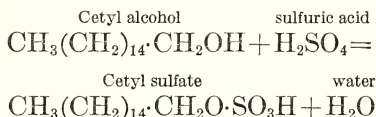
A recent development is the production on a commercial scale of the newer synthetic nonsoap detergents, the salts of the sulfates and sulfonates of the higher fatty alcohols, obtained from fatty acids or their triglycerides (fatty oils). Organic acids are characterized by

⁸ Chester L. Baker, *Effect of alkaline detergents upon metals*, Ind. Eng. Chem. 27, 1358-64 (1935).

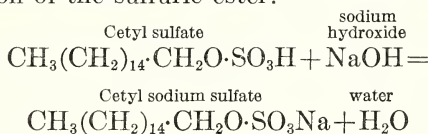
the carboxyl group (COOH) and the alcohols by the hydroxyl group (OH). The difference between the properties of the various acids and alcohols is due to the radical or radicals with which these groups are combined. The sulfates are esters of the corresponding higher fatty alcohols, the sulfur atom of the acid group (SO₃H) being united to the end carbon of the alcohol through an oxygen linkage, as —C.O.SO₃H. The sulfonates are true sulfonates, the sulfur atom of the acid group being linked directly to a carbon atom at one end of the fatty acid chain, as —C.SO₃H. The manufacture of these products requires high-pressure apparatus and other expensive equipment and is covered by patents. The following outline will give an idea of the stages involved: (1) Reduction of the fatty acid by hydrogenation to fatty alcohol; for example:



(2) Treatment of the alcohol with sulfuric acid under suitable conditions:



(3) Neutralization of the sulfuric ester:



The true sulfonates can be prepared in somewhat the same way, but a much more intense treatment with sulfuric acid is used. A commercial sulfated fatty alcohol product may consist of a mixture of sulfates of a number of fatty alcohols, and the sodium salts are therefore often referred to as sodium alkyl sulfate. These products are also called "hymolal" (high molecular-weight alkyl) salts. The commercial materials may also contain some unchanged fatty alcohol and varying amounts of sodium sulfate. These salts are available as practically white or cream-colored powders or flakes, soluble in water and alcohol. However, solutions, such as a solution of the sodium or triethanolamine salt of lauryl sulfate are used as shampoos. These salts are practically neutral in water solution, are good wetting-out agents and emulsifiers, and have excellent lathering or sudsing properties. Their calcium and magnesium salts are soluble, hence they can be used in hard water or sea water without the formation of objectionable precipitates. They may be used in alkaline solutions or dilute acid solutions. These salts are used for washing fine fabrics (especially silk and wool) in the household, especially in hard-water districts. They have been used to some extent in power laundries and for a variety of detergent operations in the textile and other industries. Another important class of wetting and detergent materials includes alkyl sulfonates containing an amino group. Research

in the field of alkyl sulfates and sulfonates and their various derivatives will, no doubt, result in a number of commercial products. A review of these newer detergents, including patents and a bibliography, can be found in a series of papers by Mullin.⁹ At this time these products are more expensive than soap. Furthermore, the long-proved value of soap is so well known, and its price is so uniformly low that it is not probable that any large proportion of soap, as now used for general cleaning purposes, will be displaced by the fatty alcohol sulfates and sulfonates. However, the cost of production of this class of detergents will no doubt be reduced and their use so extended as to increase their competition with soap for general purposes, especially in districts where the water is very hard.

2. SULFONATED (SULFATED) OILS

Sulfonated oils are not used to any great extent in the manufacture of soaps. They have been used in soapless shampoos, some shaving creams, as emulsifying agents, and for other purposes. However, these oils are widely used in the dyeing and printing of textile fabrics. They are sometimes called "soluble oils." The best known of these oils is sulfonated castor oil or turkey-red oil. Olive, corn, neatsfoot, lard, whale, cod, and other oils, as well as the fatty acids obtained from them, are sulfonated and are used in various industries. Mineral oil is sometimes a constituent of the commercial products. Sulfonated oils have the advantage in textile and other processes of not being affected by dilute mineral acids or by the salts in hard waters.

3. SPECIAL PHOSPHATES

A comparatively recent development has been the production on a commercial scale of a special sodium metaphosphate said to be sodium hexametaphosphate $((\text{NaPO}_3)_6)$.¹⁰ This compound has certain detergent and emulsifying properties but is of special interest because of its ability to form "soluble" compounds with the calcium and magnesium constituents (hardness) of waters and to dissolve "lime soaps" (calcium and magnesium soaps), thereby regenerating soda soap and preventing the deposition of insoluble compounds or "scum" on objects being cleaned. Tetrasodium pyrophosphate, crystalline $(\text{Na}_4\text{P}_2\text{O}_7 \cdot 10\text{H}_2\text{O})$ and anhydrous $(\text{Na}_4\text{P}_2\text{O}_7)$, and a compound said to be the sodium salt of tetraphosphoric acid $(\text{H}_6\text{P}_4\text{O}_{13})$ ¹¹ also possess detergent, emulsifying, and water-softening properties. The above substances when mixed in varying amounts, depending upon the hardness of a water supply, with alkaline compounds, such as trisodium phosphate, sodium metasilicate, soda ash, modified soda, or sodium hydroxide, are widely used as dishwashing compounds, especially in washing machines. Sometimes these compounds contain small amounts of ammonium salts, and sometimes they are colored with dyes.

Compounds containing the above phosphates may be evaluated by comparing their performance in actual washing operations under service conditions. They may be evaluated in the laboratory by

⁹ C. E. Mullin, *The newer detergents*, Soap 13, No. 11, 30-33, 74; No. 12, 27-30, 73-74 (1937); 14, No. 1, 30-33, 74 (1938). *Synthetic detergents* (condensed bibliography), Soap 14, No. 2, 32-35, 73-74; No. 3, 30-33; No. 4, 32-33, 73-74 (1938).

¹⁰ R. E. Hall, U. S. Patent 1,956,515 (April 24, 1934).

¹¹ A. H. Fiske, and C. S. Bryan, U. S. Patent 2,059,570 (Nov. 3, 1936).

comparing their ability to "dissolve" calcium soap under carefully controlled conditions—the so-called "calcium-repression" test, or by a turbidity test, using a calcium chloride solution.

The corresponding potassium phosphates are also commercially available.

4. BLEACHING AGENTS

Bleaching is a chemical process and, in addition to the whitening of textile fibers, has a definite value in the removal of certain stains, mainly of an organic nature. A bleach does not necessarily eliminate the discoloring substances from a fabric; if soluble compounds are formed, they will, of course, be removed in the subsequent rinsing. On exposure to oxidizing or reducing conditions, depending upon the type of bleach used, the color may reappear. Both oxidizing and reducing bleaches are used in the laundering of textile fabrics. The former include chlorine compounds, peroxides, perborates, permanganates, and ozone; the latter sulfites, hydrosulfites, and oxalic acid. Peroxides are used for the bleaching of wool, silk, and dyed cotton goods. Hydrogen peroxide may be used with silk and wool. Sodium perborate is quite stable and is used as a component of some washing powders or soap powders. Potassium permanganate has been used on wool. It can be used in either an alkaline or acid solution, but apparently is more efficient in an acid solution. Any discoloration caused by manganese oxide can be removed by a suitable reducing agent, such as sodium bisulfite or oxalic acid, avoiding an excess.

Ozone bleaches well when allowed to act on fabrics before or during the drying in drying rooms. The fabrics are less attacked than in the hypochlorite method, but the process requires extra handling of the fabrics and increases the time of the laundering operation.

The common and most extensively used laundry bleach is sodium hypochlorite, known in the trade as "Javel water." In laundry practice the bleach is generally used in an alkaline bath, especially in the bleaching of fabrics of vegetable origin, such as cotton and linen. The bleaching solution should be free from calcium and magnesium or other substances that form insoluble soaps. Sodium hypochlorite, or "soft bleach," may be made by treating "bleaching powder" or "hard bleach" (chloride of lime, calcium hypochlorite) with an aqueous solution of soda ash; treating an aqueous solution of soda ash or caustic soda directly with chlorine; and by electrolyzing an aqueous solution of sodium chloride. The laundry operator generally prepares sodium hypochlorite solutions of a concentration giving 1 percent of "available" chlorine. Sometimes solutions are made up to 5 percent, and then diluted.

Unless controlled, bleaching is probably the most destructive of the various operations in laundering, especially to delicate fabrics. Hypochlorite should never be used to bleach silks and woollens as it damages these fibers. Cotton and linen fibers may be appreciably damaged unless the chlorine concentration, the temperature, and the time are carefully controlled. No bleach ordinarily should be used on colored or dyed goods. Metallic impurities in the soil or dirt on garments may promote the destruction of fibers by hypochlorite bleach.

Reducing bleaching agents are used in the textile trade more extensively than in the laundry industry. Sodium bisulfite is gen-

erally used. This compound is a combined bleach and sour, may be safely used on silks and wools, and is less harmful to cotton and linen fabrics than are the oxidizing bleaches. Oxalic acid is also a combined bleach and sour, but its use is restricted by cost and by its more pronounced effect upon fibers when concentrated by drying; it requires very thorough rinsing.

Often bleaching can be omitted if the household washing has been properly done. Whenever possible, the bleaching should be accomplished by exposure to sunlight and moisture; however, these agents may sometimes be deleterious to the fabric, as, for example, weighted silk fabrics or fabrics colored with certain dyes.

5. SOURS

Sours are either acids or compounds which yield acids on solution in water. A sour is used in laundry practice to neutralize any alkaline compounds remaining in the fabrics, decompose any oxidizing bleach left in the goods, dissolve certain stain-forming compounds, and to prevent starched goods from yellowing when ironed.

When goods have been bleached too heavily with an oxidizing bleach, oxycellulose may be formed. Any alkali left in the fabric reacts with the oxycellulose, especially under the influence of the ironing temperature or that of storing, to form a yellow compound. Alkali may accelerate any tendency of starches to yellow at ironing temperatures, and will affect the tint of certain blues. Wool and silk withstand the action of strong sours in fairly concentrated solutions, but cotton and linen are injured by some sours, depending upon the nature of the sour, its concentration, and the temperature. The sours generally met with in the laundry trade are acetic acid, sodium bisulfite, oxalic acid, sodium acid fluoride, and sodium fluosilicate (sodium silicofluoride). A mixture of oxalic acid and sodium fluosilicate is sometimes used. A mixture of oxalic and acetic acids has been widely used. Sodium bisulfate has been used as a laundry sour with precautions as to amounts and rinsing, but its use is inadvisable on account of its deleterious effect if left in the goods. Oxalic acid and sodium bisulfite should not be used with colored or dyed goods. Acetic acid and the fluoride type of sours are harmless to cotton and linen.

In certain districts it has been observed that occasionally some garments when hung outdoors to dry during the winter months are seriously attacked and weakened, in some cases finally falling to pieces. Work done at the National Bureau of Standards on this so-called winter damage indicates that if the final rinsing leaves the clothes slightly alkaline from sodium compounds, they may become yellow at ironing temperatures. If the final rinsing leaves the clothes slightly acid and the clothes are exposed to certain atmospheric conditions, they may be attacked, giving rise to "winter damage." In order to prevent goods from becoming harmfully acid when hung outdoors during winter, a special alkaline treatment was devised. The goods are rinsed with clear water at least once after the sour. Then calcium bicarbonate is formed in the final rinse by the action of sodium bicarbonate and calcium chloride added separately. This may be done as follows: Dissolve about 2 lb of sodium bicarbonate in 3 to 5 gal of cool water and add the solution to the wash wheel. Run the

wash wheel for 3 minutes, add a solution of 1 lb of calcium chloride in 3 to 5 gal of water, run the wheel for 5 minutes, and dump. The amounts of these reagents required will depend upon the conditions involved and the volume of water in the washer or tub. A small amount of calcium carbonate remains in the goods when they are dried. This process has been used in certain New England laundries which reported a material decrease in the amount of "winter damage." This study is reported in detail in Research Paper 294 of the National Bureau of Standards Journal of Research.

6. BLUINGS

Bluing is primarily intended to mask a yellow color, but is sometimes used in an attempt to hide bad color due to faulty washing. It is doubtful, however, if bluing can cover up poor washing. The most common substances used in laundry household bluing are indigo, soluble prussian blue, ultramarine, and blue aniline dyes. As a rule, the most satisfactory materials for bluing are indigo and aniline blue, which are not readily affected by weak alkalies or acids. Prussian blue is decomposed by weak alkalies, such as ammonia or even soap, and may thereby produce rust spots upon the goods. The aniline blues (coal-tar dyes) are in general use in the power laundries of this country. In these laundries bluing is usually done in the souring bath after the souring has been accomplished. Wool and silk have a great attraction for dyes, and if blued at all much care should be exercised.

7. LAUNDRY STARCH

Starch from various sources has practically the same composition, but differs greatly in the size and character of the grains and in its suitability for various purposes; for example, stiffening of clothes. Although rice starch is said to be the best for laundry use, a "thin-boiling" mixture of corn and wheat starches is much used in this country. In the process of ironing, part of the starch may be changed to dextrin, which adds to the gloss and stiffness. Gum arabic and wax, for example, paraffin, often are added to starch for home work to increase the gloss. In addition to giving a pleasing finish, starch protects fabrics to some extent in that dirt or soiling matter is not so readily ground into them.

VIII. DRY CLEANING¹²

1. NATURE AND APPLICATION OF DRY CLEANING

"Dry cleaning," so-called, is performed in a variety of ways, in all of which, however, the fabrics are immersed in a liquid other than water. It was formerly also known as "French cleaning" and "chemical cleaning." In this process most of the oily or fatty substances that hold dirt or "soiling matter" on or in fabrics is dissolved by the dry-cleaning fluid or solvent so that the dirt may be readily removed by mechanical agitation. Dry-cleaning soaps, and at times certain special solvents, are mixed with the dry-cleaning solvent to

¹² This section is based in large part on publications issued by the National Association of Dyers and Cleaners of the United States and Canada.

serve as detergent aids. These are said to absorb the surface moisture on fabrics, permitting greater penetration of the solvent and the "wetting" of the fabric by it. In practice, local treatments (known as "spotting") with special solvents or chemicals may be required. Sometimes it may be necessary to supplement the true dry-cleaning process by immersing and agitating the articles in water containing suitable chemicals. Special apparatus and skill are required in some finishing operations. Therefore, the term "dry cleaning" now covers all of the procedures that may be required in the renovation of articles submitted to a dry-cleaning plant.

Fabrics adaptable to the dry-cleaning process do not, when immersed in the common dry-cleaning solvents, shrink, lose shape or finish, etc., as is frequently the case in "wet cleaning"—washing in water. When they are wet or hold excessive moisture, they should be brought to an air-dry condition before subjecting them to the dry-cleaning process. The ordinary laundry type washer is generally used in the dry-cleaning plants. In the dry-cleaning process the rinses are made with clear solvent, without any additions, in order to remove all traces of soaps and loose soiling matter that may remain in the goods after the cleansing or "washing" operation. Most of the excess of solvent is then removed ("extracted") by centrifuging, and finally the last portion of the solvent is evaporated by the use of air at about 150° F in a drying tumbler, or at lower temperatures in deodorizing cabinets or rooms, depending upon the type of materials being processed. (See references at end of this circular for publications describing dry-cleaning processes, equipment, etc.)

The nature of the fibers and the dyes, condition of the fabric, furs, gloves, etc., character of soiling matter, sizing materials, weighting materials, etc., must be carefully considered in using dry-cleaning solvents and detergent aids. Drying temperatures, finish, and condition of the cleaned article, etc., must also be considered. Certain textiles are not adapted to dry cleaning: for example, rubber goods or rubberized fabric, articles fastened with marine glue, fabrics dyed with oil-soluble dyes or coloring matter, artificial flowers, certain leather and fur trimmings, etc.

2. DRY-CLEANING SOLVENTS

The dry-cleaning solvents in general use in this country fall into two classes, as follows:

(a) **PETROLEUM SOLVENTS.**—Until about 1925 the solvent in most general use in this country was ordinary motor gasoline (called by many "naphtha"), as sold at the automobile filling stations. In order to reduce the fire hazard and to obtain a solvent low in unsaturated compounds and free from "heavy ends" and sulfur compounds, the National Association of Dyers and Cleaners of the United States and Canada, through research associateships at the Mellon Institute of Industrial Research and at the National Bureau of Standards, developed a special petroleum distillate for use as a dry-cleaning solvent. This distillate, known in the dry-cleaning and petroleum industries as "Stoddard solvent," has a minimum flash point of 100° F in a closed-cup tester. Reference to a specification for this solvent will be found on page 58.

Recently a petroleum solvent with a minimum flash point of 140° F has become available. It has a higher initial boiling point than Stoddard solvent, and, like the latter, it is readily removed in deodorization. Special equipment is also available for using this solvent; however, the cleaning operations are quite similar to those used with Stoddard solvent.

(b) **CHLORINATED HYDROCARBONS.**—Carbon tetrachloride (boiling point about 170° F), perchloroethylene (boiling point about 250° F, more properly called tetrachloroethylene), and trichloroethylene (boiling point about 188° F) are the chlorinated solvents in widest use. Generally, one of these solvents is used in the cleaning unit; however, they may sometimes be mixed with some ethylene chloride, benzol, or other solvent.

Trichloroethylene is not as widely used as either carbon tetrachloride or perchloroethylene. It is said to have many advantages over the other two from the standpoints of cleaning efficiency, stability, and lower toxicity, but to have the disadvantage that it may cause the dyestuffs in many cellulose acetate fabrics to "bleed," especially when it is warm. The following remarks will be limited to carbon tetrachloride and perchloroethylene.

As the chlorinated solvents (often referred to as "synthetic solvents") are noninflammable, there is no fire hazard whatever with units using them. They are more than twice as heavy as the petroleum solvents, but they are very volatile and should therefore be kept in closed containers at all times. Owing to their lack of stability in the presence of light and moisture, with the resulting tendency to become somewhat acid, they should be carefully supervised to guard against any corrosive action on fabrics and equipment. The excess moisture in garments should therefore be more carefully controlled than in the systems using petroleum solvents. Some manufacturers recommend that garments be predried before placing them in cleaning units using chlorinated solvents. The manufacturers of these units furnish detailed information on their proper use and maintenance. Although the vapors of the chlorinated solvents have a toxic effect, they can be used with safety if properly handled and controlled. These substances have excellent solvent properties. Suitable dry-cleaning soaps increase their cleansing efficiency.

3. DRY-CLEANING SOAPS

An ideal dry-cleaning soap should be capable of cleansing all kinds of textile materials without any injurious effect on the fibers or colors. It should be readily miscible with the dry-cleaning solvent; it should leave no deposit on the goods nor impart an odor; and it should be removed completely from the solvent in the clarification or solvent recovery method employed in the dry-cleaning plant. The dry-cleaning soaps, also known as "benzine soaps," in general use in this country are soaps in which the fatty acid has not been completely saponified by alkali. They are often prepared in a gasoline vehicle, and are sometimes referred to as "superfatted soaps." They are only partly soluble in the dry-cleaning solvent (gasoline, Stoddard solvent, or chlorinated solvent), but are fairly readily dispersed or uniformly distributed in such a medium. The completely saponified (neutral) or "wet washing" soaps are practically insoluble in such solvents.

Dry-cleaning soaps vary greatly in their composition. The anhydrous soap may range from 10 to 50 percent and the free fatty acids from 10 to 20 percent, the remainder generally consisting of water and organic solvents. The fatty material in such soaps is usually oleic and stearic acids; however, fatty oils (triglycerides) are being used to some extent to replace the oleic acid (red oil). The alkali used in making these soaps is usually caustic potash, caustic soda, ammonia, or triethanolamine. The solvents include gasoline, benzol, toluol, xylol, chloroform, alcohol, carbon tetrachloride, trichloroethylene, isopropanol, etc. In manufacturing dry-cleaning soaps the organic solvents and free fatty acids (and fatty oils, if used) are first put into the soap kettle; then a concentrated aqueous solution of the lye is slowly added while the mixture is stirred. The mixture is heated carefully to avoid boiling away too much of the volatile solvents. After saponification is complete, an excess of free fatty acids (oleic and stearic) is added, with stirring, and the product may then be allowed to age.

A simple dry-cleaning soap can be made by dissolving 1 lb of caustic soda in 2 qts of soft water and pouring the solution in a small stream, with constant stirring, into a mixture of 6 qts of oleic acid and 8 qts of ordinary gasoline and finally stirring the whole mixture for 15 to 20 minutes. Caustic potash can be substituted for the caustic soda. In the dry-cleaning plant a stock solution is made by dissolving a definite quantity of the dry-cleaning soap in a definite volume of the dry-cleaning solvent. This stock solution is then added to the washer in quantities determined by the capacity of the washer, size of load, type of goods, degree and character of soiling, etc.

Some dry-cleaning soaps are made by dissolving the caustic alkali in alcohol and adding the solution to oleic acid. Special dry-cleaning soaps prepared for specific purposes, such as leather glove cleaning, are being widely used to eliminate a large number of "spotting" operations. These "selective" or special soaps may contain various volatile solvents incorporated with the dry-cleaning soap base, such as chloroform, carbon tetrachloride, ethyl acetate, amyl or butyl alcohol, amyl acetate, ethylene chloride, ether, trichloroethylene, pyridine, phenol, cresol, hydrogenated phenols ("hexalin", etc.). These "prespotting" or "hand-brushing" soaps contain a comparatively large amount of water, but are practically "soluble" in the dry-cleaning solvent, the "hexalin" or other added substance acting as a "carrier" for the water. The soiled garment may be thoroughly "wetted" with clean dry-cleaning solvent, brushed with the prespotting soap (or the soap applied with a spatula), and then put through the usual cleaning process. However, in modern practice the garment is first rinsed in clear solvent, then given a treatment or wash with the dry-cleaning solvent containing ordinary benzine soap, followed in many cases by treatment with the solvent containing the so-called "prespotting" soap. Since about 1929 the use of a high concentration of ordinary benzine soap in cleaning certain types of goods has become general practice. This soap is known in the industry as the "strong soap solution" or "S. S. S." Some stains may require spotting before dry cleaning.

The treatment with prespotting soap removes most of the ordinary spots or stains and results in faster work and more economical operation. The older method required hand spotting of all spots or stains not removed by the solvent containing ordinary dry-cleaning soap.

For cleaning moderately soiled garments, the use of a simple dry-cleaning soap in the washer is satisfactory. Apparently, the use of complex mixtures is not necessary, except as prespotters.

In the industry, dry-cleaning soaps or aids are generally divided into three classes: (1) Paste soaps, (2) "soluble" or liquid soaps, and (3) "detergents" or "detergent" soaps. In the third class are included various products claimed to have special properties. Tests carried out in 1936 in the laboratories of the National Association Institute of Dyeing and Cleaning with soaps of different types, using a soiling of the carbon type on white wool garments, and in a number of dry-cleaning plants, indicated that the paste soaps were superior to the other types under the conditions of test. However, with a different type of insoluble soiling and with some other fiber, the paste soaps may not be superior.

Work at the National Bureau of Standards by research associates of the National Association of Dyers and Cleaners has shown that when furs are to be dry-cleaned by immersion in Stoddard solvent or "naphtha" the addition of a small percentage of paraffin to the dry-cleaning solvent (a stock solution should be kept separately from the solvent used in the washers or held in the storage system) improves the appearance and pliability of furs. Recommended standards of practice for dry-cleaning furs, when such a process is used, have been formulated and published in Bureau of Standards Technologic Paper No. 360.

Whether or not a fur garment should be dry-cleaned depends upon the type of fur and the condition of the garment. A common method in general use by furriers and some dry cleaners invokes the drumming of furs in a powdery material dampened with solvent. This is the so-called "drum" or furrier's method of cleaning.

4. DRY-CLEANING PROCESS

In dry-cleaning plants the cleaning cycle is usually separated into three distinct runs: "Break," soap, and rinse. These operations are always followed by extraction and deodorization. The optimum temperature for cleaning the average type of goods is stated to be 70° to 80° F. However, with very badly soiled goods, such as greasy overalls, a higher temperature may be used.

In the "break" the garments are treated in the wash wheel with clear solvent and the wheel is run about 10 to 15 minutes, with the solvent circulating through a filter. Sometimes, instead of circulating the solvent, one short batch run of 5 to 7 minutes is made. The "break" loosens and carries away particles of insoluble soiling matter in the garments. The solvent is drawn off and fresh solvent and soap are added. The amount of soap used for a given volume of solvent will vary with the type of garments in the washer, for example, with silks and fancy garments, about 1 gal of soap stock (1 lb of soap) is added for each 25 gal of solvent; with heavy woolens, about 1 to 2 gal of soap stock for each 50 gal of solvent. The garments are given a batch run with the soap for about 20 to 40 minutes. The soap solution is drained off and the garments are rinsed with continuous circulation of completely clarified solvent until the solvent leaving the load is clear. Sometimes two or three batch rinses of 5 to 7 minutes each are used instead of the continuous circulation of the solvent. The

garments are next carefully removed to a drain board, excess solvent is allowed to drain back to the washer, and the garments are then extracted in a centrifugal extractor (not over 1 minute for silks or 3 minutes for woollens, after the maximum speed has been attained). Silk garments and wool garments with silk linings are next deodorized by hanging them in drying cabinets supplied with a good circulation of fresh, clean air at a temperature not over 120° F; all woolen materials are hung or tumbled in a circulation of clean air at 120° to 160° F.

Should any spots or stained areas remain that appear to the experienced operator as removable by spotting methods, the garments are returned to the dry-cleaning room, saturated with Stoddard solvent, and treated with a special spotting soap.

Laces, tulles, and other delicate materials may either be cleaned by hand in a concentrated soap solution, or, if they will withstand the mechanical action of the washer, they may be put into net cotton bags and washed in it.

Velvet garments should be turned inside out and pinned along the bottom to prevent their edges rolling during the cleaning process.

The "strong-soap-solution" method is said to have the advantages of producing better cleaning, requiring less spotting, prespotting, and naphtha brushing, saving time, costing less in the long run, producing brighter colors, and reducing the amount of wet cleaning.

The strong soap solution is used for successive loads of garments until too dirty for further use.

METHOD FOR CLEANING COTTON AND LINEN.—Cotton and linen fabrics are seldom dry cleaned, unless combined with woollens or silks or used in heavy draperies. Then they are handled in the same manner as silks.

The cleaning procedure outlined above is based on the use of Stoddard solvent. Cleaning with the chlorinated solvents is said to require about one-half the time indicated for Stoddard solvent.

The following have been reported by Randall¹³ as typical procedures for the chlorinated solvents:

(1) *With a Filter Circulation.*

(a) *Break.*—Run for 5 minutes or until the sight glass shows that the solvent is clear.

(b) *Soap.*—Run for 10 minutes without the filter circulation (batch run), using 1 pt of soap solution to each 25 gal of solvent in the cylinder, or 1 oz of soap for each 5 lb of garments.

(c) *Rinse.*—Run for 5 to 7 minutes on the pressure filter circulation until the sight glass shows clear. Drain and give one batch rinse of 3 minutes.

(d) *Extraction.*—Extract for 2 to 3 minutes.

(e) *Drying.*—Dry at 120° F for silks and 160° F for woollens until the solvent has been recovered from the garments.

(2) *Without a Filter Circulation.*

(a) *Break.*—Run for 3 to 5 minutes with the addition of ½ pt of soap (to prevent reabsorption of soil by the garments) for each 25 gal of solvent in the cylinder. Drain.

¹³ See footnote 12.

(b) *Soap*.—Refill the machine with clean solvent and add 1 pt of soap for each 25 gal of solvent in the cylinder, or 1 oz of soap for each 5 lb of garments. Run for 10 minutes. Drain.

(c) *Rinse*.—Make three batch runs of 5 minutes, 3 minutes, and 3 minutes, respectively, draining after each run.

(d) *Extraction and Drying*.—Carry out as stated for filter circulation.

There should be good ventilation in all places where dry-cleaning solvents are used or handled. This applies especially to the chlorinated solvents, owing to their volatility and the toxicity of their vapors. These solvents should not be used in the open atmosphere. In storing these solvents moisture should not be allowed to accumulate. Since water is lighter than the solvents, it can be drawn or skimmed off. Some manufacturers recommend that garments be predried before placing them in the cleaning units. In cleaning pressure filters, stills, tanks, etc., all liquid should be drawn off and the equipment aired before attempting to remove muck or sludge. As the vapors of the chlorinated solvents are heavier than air, air ducts and suction fans should be placed at floor levels.

The equipment used for cleaning with chlorinated solvents generally is of two types, the "closed unit" and the "open-type system." The open-type system does not recover the solvent in drying; the operator is subjected to the possibility of breathing the vapors; and the solvent loss may in some cases be quite expensive. However, the manufacturers of this type of equipment enclose their systems and install suction fans to remove the vapors in order to minimize the health hazard, and claim that the solvent losses in drying approximate the cost of the extra equipment, steam, water, and power required for recovery of the solvent.

The closed-unit system has proved to be the most practical and is used by many dry-cleaning plants and laundries. This type is known as a "unit," since the washing or cleaning, extraction, and drying are carried out in the same cylinder. The unit is provided with a recovery condenser, and may use a deodorizing damper, to prevent escape of the solvent vapor to the atmosphere. Some large cleaning plants have several batteries of these units. There are a number of closed-type units on the market, and the manufacturers furnish instruction manuals covering their operation and maintenance.

5. STAIN REMOVAL OR "SPOTTING"

Successful spotting requires the most skillful and experienced employees in the dry-cleaning industry. In the modern dry-cleaning plant, spotting is done on specially designed porcelain-topped boards, called "spotting boards." The spotter inspects fabrics for stains and defects, and decides upon and applies the best and most economical procedure to follow. He must be familiar with textile fibers, sizing materials, the various dyestuffs used, the various stains or spots that may be encountered, the reagents or chemicals to be used and their action on fibers and dyes. He must know that certain stains are changed and become practically insoluble in reagents, or "set," if carried through the dry-cleaning process without preliminary treat-

ment, and that stains due to linseed oil, paints, varnishes, etc., are best treated before dry cleaning.

Spotting reagents should be used in such sequence as to avoid the "setting" or fixing of stains in fabrics, to reduce the number of reagents required to the minimum, to prevent injury to the fabric, and to leave the dye undisturbed in the fabric.

Spotting is done either before or after dry cleaning to avoid, if possible, any wetting with water which would remove the sizing in many fabrics and increase the cleaning cost. In treating stains on colored goods the dye is frequently removed or changed by the stain-removing reagent. When this occurs the spots are sometimes "touched up" or "filled in" by an appropriate dye, the so-called "spot dyeing." The dye or color may be completely removed, or "stripped," and the fabric redyed.

Stains may be classified under various headings, such as corrosive and noncorrosive, and according to the effects produced by high temperature, atmospheric exposure, sunlight, bleaching agents, etc. Some stains may be of such a nature as to be practically nonremovable, especially after having become set or fixed in the fabric. The "tendering" of fabrics may be due to errors or mistakes of the manufacturer, the user, or the cleaner. Furthermore, there may be hidden damage to fabrics before submission to the cleaner that may be manifested only after subjecting them to the various cleaning operations. The various reagents that may be used, the different types of stains that may be encountered, and methods of stain removal cannot be covered in this circular. Such information will be found in the references given at the end of this circular, particularly United States Department of Agriculture Farmers' Bulletin No. 1474 on Stain Removal from Fabrics—Home Methods.

6. FINISHING

The object of finishing is to give the cleaned or dyed garments the required feel, luster, shape, and a good appearance in general. Owing to the wide variety of materials submitted to the dry cleaner, finishing has become a highly technical operation, which includes ironing, pressing, steaming, stretching, etc., and requires the use of many special pieces of equipment; for example, so-called puff irons to finish gathers, ruffles, etc., special steam boards for velvets, special pressing machines for men's garments, special equipment for ties, hats, gloves, etc.

7. RECLAMATION OF PETROLEUM SOLVENTS

In the dry-cleaning process the soiling matter removed from the garments is held in suspension by the dissolved dry-cleaning soap. The solvent becomes discolored and rancid or foul by decomposition products and soiling materials and, if cleaning is done by the batch process, it finally becomes unsuited for use. It is then purified and recovered. The time required for the solvent to become too foul for use depends upon a number of factors, such as the nature of the soiling materials encountered, the number of garments cleaned, the character of the solvent, soap, appliances, condition of storage, etc. The dry-cleaning industry of the United States consumes over 30,000,000 gal. of solvent a year. Obviously, a rapid and economical process for

the purification and recovery of used solvent is of vital interest to this industry.

Various processes of reclamation (also called purification and clarification) have been proposed. The following have probably been the most widely used:

(a) **DISTILLATION PROCESS.**—In the distillation process there may be loss of solvent by incomplete condensation of the vapors, or by retention in the still residue (soiling matter, soap, etc.), the recovered solvent may not be as sweet as that purified by some of the other methods, and fuel consumption may be an adverse factor. With ordinary motor gasoline there would be a loss on account of the heavy ends which cannot be distilled readily; such loss should be negligible with Stoddard solvent if distilled under a partial vacuum.

(b) **ALKALI-CARBON PROCESS.**—In this process the dry-cleaning ("superfatted") soap and dissolved fatty matter are completely saponified, forming water-soluble soaps that are practically insoluble in the dry-cleaning solvent. These soaps precipitate and carry down with them much of the finely divided soiling matter held in suspension, leaving coloring matter in solution. Coloring matter, odors, and probably certain dissolved compounds are removed by intimately mixing the used dry-cleaning solvent with an activated carbon.¹⁴ The alkaline compounds generally used are trisodium phosphate, caustic soda, or sodium silicate. The used solvent may be treated with an aqueous solution of the alkali, the precipitated matter removed by settling or centrifuging, and the recovered solvent then treated with activated carbon. Or, the activated carbon may be mixed with a small amount of clean solvent and the mixture poured into a cone-bottom settling tank; the alkaline compound is dissolved in water and the solution poured into the settling tank; the tank is filled with the dirty, used solvent and the mixture is agitated for 15 minutes by pumping (centrifugal pump) from the upper portion of the tank, the solvent being discharged back into the cone bottom of the tank. The mixture is allowed to stand until the reagents and impurities have settled out, and the supernatant, purified solvent is drawn off into storage tanks.

One charge of activated carbon and alkali may be used for several lots of used solvent, depending upon the condition of the solvent being purified, amounts used, etc. After a "purifying charge" has become too foul for further use, the dry-cleaning solvent held by it may be recovered by treating the mixture with an equal volume of water and letting stand a few hours for the water, reagents, and impurities to settle, leaving the dry-cleaning solvent as the upper layer. In the alkali-carbon process, treatment with live steam or excessive agitation may cause emulsions that are difficult to handle. If trisodium phosphate is used, the temperature should be maintained between 60° and 80° F. This process as above outlined is for batch treatment of the dirty, used solvent pumped from underground storage tanks, but it can also be readily applied in the continuous systems designed for the use of caustic-alkali solutions alone.

(c) **ALKALI-CONTINUOUS PROCESS.**—In this process the dirty solvent is pumped from the washer through an aqueous solution of caustic soda containing activated carbon, then washed with water,

¹⁴ Activated carbon is carbon which has been treated chemically and otherwise in order to increase its decolorizing and adsorptive properties.

filtered, and returned to the washer. The dirty solvent is often run from the washer through a centrifugal clarifier, then treated with the alkali solution, washed, passed through the clarifier or "purifier," filtered, and returned to the washer. A continuous system must handle many times the volume of solvent that would be handled by a batch system cleaning the same quantities of goods, and, therefore, the cost of treatment must be low. In the continuous processes, the color may not be entirely eliminated from the solvent, but it is markedly reduced.

(d) **ACID-BASE-CONTINUOUS PROCESS.**—In this process the dirty solvent is run from the washer through a centrifugal clarifier; a portion of the clear, dark solvent from the clarifier is treated with concentrated sulfuric acid and then with a neutralizing solution (caustic soda). The treated, decolorized solvent is then returned to the main stream, passing through the clarifier (to remove the last traces of caustic soda) back to the washer.

(e) **FILTRATION.**—Direct or gravity filtration of the dirty solvent through fuller's earth, sand, or charcoal is difficult and time consuming owing to the slimy nature of the solids to be removed. The probable loss of solvent by evaporation and otherwise is also a factor that has caused the practical abandonment of this process in this country.

A later development in the application of the chemical processes (such as the alkali carbon, alkali continuous, etc.) is the passage of the solvent, containing alkali, activated carbon, diatomaceous earth or other filter aid, under pressure through filters, the clear, "purified" solvent returning to the washer or a storage vessel.

(f) **PROCESSES USING SPECIAL REAGENTS.**—Mixtures of caustic soda, chip soap, soda ash, and other materials have been used in the purification of dirty solvent both by batch and continuous treatments. Good results have been reported in certain plants using a commercial product consisting of a mixture of trisodium phosphate, soda ash, colloidal clay, colloidal cellulosic matter, and soap. The dirty solvent is run from the washer into a tank containing the purifying agent and trisodium phosphate in water; after agitation, the solvent flows into a tank containing water and from this into a series of tanks in tandem. The suspended matter and aqueous solution settle out in the series (mainly in the first tank). The reclaimed solvent finally passes through a cloth filter to insure removal of all solid matter, and is then returned to the washer. One charge of the reagents will handle a large volume of dirty solvent, the amount depending upon the condition of solvent and the quantities of materials used.

3. ELIMINATION OF STATIC ELECTRICITY

Ignition of the dry-cleaning solvent by static electric sparks produced by the rubbing of textile fabrics in the solvent has been the cause of many fires with resulting loss of life and property. It has been noted that such spontaneous firing generally occurs during the cold months, when the relative humidity is low, and in the rinsing operations. In 1893 Richter reported that a small amount of magnesium oleate dissolved in benzine prevented electric excitation of the solvent. It was later found that the ordinary dry-cleaning soaps

acted similarly. Hence, the washer is comparatively free from this hazard. It was then suggested that a very small amount of the soap be dissolved in the rinsing solution, but this would leave soap in the goods. To reduce this fire hazard, the National Association of Dyers and Cleaners developed the Stoddard solvent referred to above. This association has also shown that properly "humidified" garments would practically eliminate the danger, and has recommended that a relative humidity of 70 percent be maintained in the receiving department. The time required for the handling of the garments in this department is sufficient to permit the absorption of sufficient moisture to prevent the production of static sparks during the subsequent cleaning process. Line shafting and machines should be properly grounded. This and other precautions are specified by the fire-protection organizations in the safety codes which cover the use of petroleum distillates.

9. CARPET AND UPHOLSTERY CLEANERS

Rugs and carpets, although frequently dry-cleaned, are probably more often wet-cleaned. The soap stock used for wet-cleaning can be made as follows: Cover 2 lb of a neutral low-titer soap (wet washing soap) and $\frac{1}{2}$ lb of trisodium phosphate with soft water, heat with direct steam until a clear solution is obtained, shut off steam, and add sufficient cold, soft water, with constant stirring, to make a total volume of $12\frac{1}{2}$ gal. Resizing is generally necessary.

Spots and grease on upholstered furniture and automobile upholstery often can be removed by brushing with a small amount of solvent, and quickly wiping with a clean cloth to prevent the solvent from penetrating too far. Carbon tetrachloride has been recommended for this purpose because it is noninflammable. The following formula has been suggested for a cleaner for silk, cotton, velour, velvet, and plush upholstery: Mix $\frac{1}{2}$ gal of Stoddard solvent with $\frac{1}{2}$ gal of carbon tetrachloride, and add 2 oz of turpentine, 2 oz of denatured alcohol, and $\frac{1}{2}$ oz of benzine soap (dry-cleaning soap). Shake the mixture occasionally while using.

Upholstery which is rather generally soiled may be wet-cleaned, provided a trial on a small area that will not be noticed indicates that the colors will permit. A soap solution or jelly at room temperature is applied sparingly to a square foot or so of the fabric with a soft brush, cloth, or sponge, using a quick, light stroke to create a fluffy suds uniformly over the area. The suds should not penetrate far and should be quickly wiped off, or pressed off with a dull knife. The remaining soap is removed by applying clean cloths wrung out of warm water and then using a vacuum cleaner with a rubber hose attachment. Care should be taken throughout that the upholstery does not get any wetter than is necessary. Coconut oil or olive oil soap is preferred because it can be removed from the upholstery fabric readily. A formula suggested by Edwards¹⁵ is as follows:

Dissolve 2 oz of pure olive oil soap and 2 oz of pure coconut oil soap in 3 gal of hot water. Add 4 oz of glycerol and 1 oz of borax. When the solution becomes lukewarm, add 2 oz of ethylene chloride.

¹⁵ George H. Edwards, *The renovation of upholstered furniture, A field for rug cleaners*, Starchroom Laundry J., pp. 63-65 (Aug. 15, 1934).

IX. POLISHES

Precaution.—Gasoline, turpentine, petroleum spirits, and many other volatile organic solvents are very inflammable. Care should be taken in using these solvents, or preparations containing them, to have good ventilation and to avoid electric sparks, open flames, or smoking in the rooms or other spaces. Oily and greasy rags should be immediately destroyed after using them or be kept in closed metal containers. Animal and vegetable oils are the most likely to undergo spontaneous combustion.

Formulas.—The National Bureau of Standards has not developed standard or recommended formulas for manufacturing various polishes. The formulas given in this section have been obtained from various sources. As the Bureau has not tested many of these formulas, they are to be considered as suggestions to serve as a basis for experimentation.

1. FURNITURE AND AUTOMOBILE POLISH

Polishes that are suitable for furniture can be used on automobiles also, provided the finishes are of the same type and in practically the same condition. Varnish, ordinary enamel, cellulose ester (lacquer), baked enamel, and synthetic resin finishes are the surfaces that are generally encountered. There are differences in the hardness of finishes, the fastness of colors, and the resistance to solvents and abrasives.

Furniture and automobile polishes should remove dirt and grease readily from the surfaces, restore their luster, and be nearly completely removable, so as not to leave the surface in such condition as to hold dust or to leave any objectionable odor. Such polishes should contain no alkali or alkaline compound that will attack finishes; emulsions should be stable or constant; the nature and amount of solvents and oils used should be duly considered; for example, alcohol, benzol, and other solvents may seriously attack cellulose ester (lacquer) finishes. Nitrobenzene (nitrobenzol or "oil of mirbane") should not be used to impart odor to polishes, as its vapors are poisonous.

(a) OIL POLISHES.—Most of the straight oil polishes consist wholly, or mainly, of a mineral oil. Mineral oil polishes are cheap and give a glossy polish if rubbed off thoroughly. Mixtures of mineral oil (paraffin oil) and linseed oil, usually with other ingredients, are also used. Linseed oil is used as a component of many polishes for varnished surfaces. Polishes containing it or other drying oil should be rubbed off thoroughly from the surface being polished. Cloths used for applying the polish and rubbing down the surface should be kept in tightly closed tin containers because of the danger of spontaneous combustion.

(b) WAX POLISHES are made in paste and liquid form. Some of the emulsion polishes contain some wax, such as beeswax, carnauba, bleached montan, ceresin, and synthetic waxes. Although beeswax is used in many polishes, the harder waxes with higher softening or "melting" points, such as carnauba wax, are to be preferred. Some of the wax polishes soften at fairly low temperatures and may whiten

by long contact with water. Polishes showing these properties would be more satisfactory on furniture than on automobiles.

(c) SPECIAL MIXTURES.—Most of the commercial polishes probably fall under this heading. These polishes may consist of mixtures of oils, waxes, volatile solvents, abrasives, acetic acid (or vinegar), antimony trichloride ("butter of antimony"), camphor, drier, etc. Oil-soluble dyes are sometimes used to impart a red or other color to such polishes. Essential oils are sometimes added to impart a pleasant odor or to mask the odor of certain ingredients. Many of these polishes are emulsions. The abrasive used in making a polish, or a combined polish and surface cleanser, should be selected with care in order not to scratch or otherwise mar the finishes on which the polish may be used. Pumice, tripoli, diatomaceous earth (infusorial earth, tripolite, diatomite, kieselguhr, etc.), chalk, fuller's earth, bentonite, and air-floated silica are some of the commonly used abrasives. The abrasive should be a uniform and very finely powdered product. Very fine abrasives are apparently used in small amounts in the preparation of some polishes for cellulose ester (lacquer) finishes. The polishes for varnish and ordinary enamel coatings as a rule do not contain any abrasive, as these finishes are easily scratched.

(d) SUGGESTED FORMULAS (see page 42).

1. Formula developed by the Bureau of Construction and Repair, Navy Department, for use on varnish and paint coatings on wood.

Material:	Pound
Cider vinegar.....	125
Petroleum spirits.....	226
Turpentine.....	135
Denatured alcohol.....	22
Boiled linseed oil.....	100
Raw linseed oil.....	121

The quantities given above are sufficient to make 100 gal. of the polish. If ounces are used instead of pounds, the quantity will be $6\frac{1}{4}$ gal. Polishes containing 4 to 6 percent of acetic acid (vinegar) should not be put in metal containers.

2.

Raw linseed oil.....	pint.....	1
Turpentine.....	pints.....	2
Beeswax.....	ounces.....	1 to 2

Dissolve the beeswax in the linseed oil by heating slightly, remove from the source of heat, add the turpentine, and mix. Shake well before applying.

3. A straight mineral oil, neutral in reaction, such as transformer oil or paraffin oil.

4. Mix 1 pt of linseed oil, 3 pt of water, and 1 pt of denatured alcohol. Shake well before applying.

5. In discussing the formulation of furniture and automobile polishes Auch¹⁶ gives a number of typical formulas to serve as a guide in manufacturing such products. For example, he gives the following formula for the "oil and soap emulsion" type of furniture polish:

¹⁶ Ralph H. Auch, *Furniture polishes*, Soap 12, No. 4, 30-33, 61 (1936); *Auto polish*, Soap 12, No. 9, 98-101 (1936).

Material:	Parts (by weight)
Paraffin oil.....	25
Naphtha.....	12
Pine oil.....	1.5
Stearic acid (double-pressed).....	4
Denatured alcohol.....	2
Triethanolamine.....	2
Water.....	53.5

Mix the first four ingredients, and warm the mixture (to about 140° F) until the stearic acid is completely melted. Mix the last three ingredients in a second container, and warm the mixture to about 140° F. Then add the latter mixture to the former in a thin stream while agitating, and continue the agitation until cool. By replacing part of the paraffin oil with "deodorized" kerosene or "varnish makers' and painters' " naphtha, the cleansing action might be increased and the tendency toward showing finger marks reduced. The addition of from 1 to 10 percent of a finely powdered abrasive in this formula would give a polish with more rapid cleaning power, but one that should be used cautiously to prevent marring the finish.

6. As an example of the "butter of antimony" type of polish, a formula recommended by the American Pharmaceutical Association ¹⁷ for use on coatings on wood has been used, as follows:

Material:	Parts (by volume)
Linseed oil.....	400
Alcohol.....	100
Oil of turpentine.....	100
Antimony trichloride solution (sp gr about 1.5).....	25
Dilute acetic acid (about 6%).....	100

Add the solution of antimony chloride last and mix thoroughly. Polishes containing acid should not be put in metal containers.

7. Emulsion polishes similar to the following have been suggested as a "cleaner and polish" for cellulose ester (lacquer) finishes:

Material:	Parts (by weight)
Carnauba wax.....	4.5
Beeswax.....	2.0
Mineral spirits.....	39.0
Finely powdered diatomaceous earth or tripoli (325 mesh or finer).....	12.5
Stearic acid.....	3.5
Triethanolamine.....	1.25
Water.....	37.25

Add the stearic acid and triethanolamine to the water, and heat to boiling in order to form a soap (triethanolamine stearate) solution. Dissolve the waxes in the mineral spirits by warming in hot water, add the abrasive to this solution, and mix by stirring or shaking; then add this mixture to the warm soap solution with agitation. The soap solution should not be too warm, otherwise the mineral spirits may boil out of the vessel. Shake well before applying.

This type of polish should be used with care to avoid marring the finish by too vigorous rubbing. Polishes which contain no abrasive are also in use for cellulose ester coatings. The formula listed, or a modification of it, could be used, omitting the diatomaceous earth or tripoli.

¹⁷ The Pharmaceutical Recipe Book. Prepared by the committees on recipe book and on unofficial formulas of the American Pharmaceutical Association (J. B. Lippincott Company, Philadelphia, 1929).

8. Wax polishes are widely used on both automobiles and furniture. A wax polish or coating gives a good finish, but requires more labor in its application than other types of polish, especially paste waxes. A paste wax may be made by the following formula:

Material:	Parts (by weight)
Carnauba wax.....	2
Ceresin.....	2
Turpentine.....	3
Gasoline (sp gr about 0.73).....	3

Melt the waxes by heating in a vessel placed in hot water (not over a fire), add the turpentine and gasoline, and cool the mixture as rapidly as possible, while vigorously stirring to produce a smooth creamy wax.

This formula might be modified, as determined by experiment, by mixing other waxes with the carnauba wax base, for example, candellila wax, chinese wax, montan wax. The carnauba wax might be replaced in part by some of the synthetic waxes and some of the varnish resins might be incorporated in the mixture. By increasing the amounts of turpentine and gasoline a liquid wax may be obtained.

9. Water-emulsion waxes, commonly called "no-rubbing" liquid waxes (see p. 48), are also used on furniture, but are apparently not being used on automobile finishes, presumably because the emulsifier is not completely waterproof. Some of these emulsions may be detrimental to lacquer films.

It should be noted that the preparation of wax polishes requires experience and attention to the details, which must be determined experimentally for a particular mixture. For large-scale work, jacketed kettles that can be heated by steam or hot water and cooled by running water, strainers, and motor-driven stirrers or agitators are used.

2. METAL POLISH

(a) GENERAL.—Although polishing powders are in use, metal polishes usually consists of some abrasive material in suspension in a liquid or semiliquid vehicle. The principal difference in composition between the paste and liquid polishes is in the vehicle employed. The abrasive materials should possess such hardness, fineness, and shape of particles as will best accomplish the desired polishing without scratching. Metal polishes should not contain mineral acids or other materials that may have an injurious effect on metals. They should not contain cyanides or nitrobenzene and should be free from disagreeable odor. Obviously, a milder abrasive, such as rouge (oxide of iron), powdered talc, or precipitated chalk (calcium carbonate), is required for highly polished surfaces than for relatively dull surfaces, such as kitchen utensils, for which various siliceous materials are generally employed. The vehicle in the pastes is usually a petroleum product (heavy mineral oil, vaseline, paraffin, etc.) or a fatty product (stearin, tallow, stearic acid, oleic acid, etc.) or both, to which soap and other materials (for example, oxalic acid, cream of tartar, etc.) are sometimes added. Pine oil is also a common and valuable solvent in soap-base metal polishes. It gives body and helps hold the abrasive matter in suspension. The noninflammable liquid polishes usually have as a vehicle water containing soap with

kerosene and ammonia, or a mixture of kerosene or other petroleum distillate, with sufficient carbon tetrachloride to render the mixture noninflammable. The inflammable polishes usually contain gasoline, kerosene, or other petroleum distillate. As a rule, the liquid polishes are more efficient where much tarnish is to be removed, but they should be used with care if they contain inflammable ingredients. The paste and liquid polishes sometimes contain essential oils to mask the odor of certain ingredients.

Polishing powders may be a single substance, such as rouge or chalk, or a mixture of various abrasives with or without added materials. On plated ware, such as chromium plate, nickel plate, silver plate, etc., only the mildest abrasive should be employed because of the thin coatings commonly used. Precipitated chalk, rouge, powdered talc, or other finely powdered abrasive, free from hard or gritty particles would probably be the safest abrasive to use.

(b) SUGGESTED FORMULAS (See p. 42.) Numerous formulas may be found in the formularies and in articles in technical journals. The following have been taken at random as examples.

1. Groggins and Scholl¹⁸ have recommended orthodichlorobenzene as a cleaner for metals and as an ingredient of metal cleaners. A paste prepared by mixing one part of precipitated chalk with five parts of orthodichlorobenzene and applied with a cloth is said to be very effective for cleaning and polishing silverware and other metals in the home and for removing rain spots from chromium-plated and nickel-plated automobile radiator shells. The compound may be mixed with other abrasives as absorbents to yield polishing pastes. Tableware and kitchen utensils polished with such products should be dipped into boiling water before they are used again.

2. A paste polish containing pine oil may be prepared as follows:

Material:	Parts (by weight)
Chip soap.....	10
Silica dust.....	20
Air-floated tripoli.....	20
Pine oil.....	2
Water.....	48

Dissolve the soap in the hot water, and add the previously mixed silica and tripoli with stirring; then add the pine oil, with stirring, and run the hot mixture into flat cans. The abrasive (silica and tripoli) should be of such fineness that practically all of it will pass through a No. 325 sieve.

3. The following has been suggested for an experimental liquid polish:

Material:	Parts (by weight)
Oleic acid.....	2.5
Orthodichlorobenzene.....	50
Pine oil.....	2.5
Diatomaceous earth (air-floated).....	10
Silica dust.....	10
Strong ammonia (26° Be.).....	2.5
Water.....	22.5

Thoroughly mix the first five ingredients, dissolve the ammonia in the water, and then add the ammonia solution to the mixture, with vigorous stirring.

¹⁸ P. H. Groggins and Walter Scholl, *Orthodichlorobenzene—an excellent cleaner for metals*, Ind. Eng. Chem, 19 1029-30 (1927).

Treating the clean, dry, metal surfaces with a protective coating would retard tarnishing and should obviate the necessity of frequent repolishing. The Bureau has not developed formulas for coatings to retard or prevent the tarnishing of metals. Clear nitrocellulose lacquers containing synthetic resins or condensation products are marketed as clear metal lacquers and are being used as protective coatings to retard the tarnishing of bronze, brass, and copper exposed to the weather. Information on clear metal lacquers might be obtained from the manufacturers of such products.

Formulas 2 and 3 are from a paper by Auch.¹⁹ This paper also discusses at some length the formulation of silver polishes.

(c) ELECTROLYTIC METHOD FOR SILVER.—Silver and silverware are also cleaned, especially in the household, by the so-called "electrolytic method." This method depends upon the fact that when silverware is heated in a solution containing about $\frac{1}{2}$ oz of sodium bicarbonate (baking soda), and $\frac{1}{2}$ oz of sodium chloride (common salt) to each quart of water, in contact with certain metals, such as zinc or aluminum, the tarnish is removed with practically no loss of silver. In using this method it is necessary to rinse the articles very thoroughly with hot water after the treatment, otherwise they will tarnish more rapidly than usual. This method leaves the surface of the silver slightly dull, and if a bright finish is required it would be necessary to polish the surfaces slightly with a mild abrasive. Sometimes sal soda or trisodium phosphate is used in hot water instead of baking soda, in which case it may not be necessary to heat the solution after introducing the silverware.

The electrolytic cleaning of silver is described and discussed in a paper by Vinal and Schramm of the National Bureau of Standards.²⁰ In this study the actual losses in weight were determined for several samples of silverware when cleaned electrolytically and by an abrasive.

3. FLOOR POLISH

Floor polishes or waxes in general use fall into two classes, as follows: Volatile organic solvent class, known in the trade as paste and liquid waxes; and water-base emulsion class, known as water-emulsion waxes.

(a) PASTE AND LIQUID WAXES.—These waxes generally consist of a mixture of natural waxes or a synthetic wax in organic solvents, such as volatile mineral oil or turpentine or a mixture of such solvents, to produce the desired consistency. The natural waxes commonly used are carnauba, candelilla, beeswax, ceresin, ozokerite, and paraffin. The liquid waxes, which are in reality mainly suspensions or emulsions, are easier of application, as they have a larger proportion of solvent (volatile mineral oil or turpentine). Ammonia, water, and other substances have also been used in formulas for these products.

Formulas (see p. 42).

(1) Material:	Parts (by weight)
Carnauba wax.....	2
Ceresin.....	2
Turpentine.....	3
Gasoline (sp gr about 0.73).....	3

¹⁹ Ralph H. Auch, *Metal polishes*, Soap 12 No. 5, 28-30, 103, 105 (1936).

²⁰ G. W. Vinal and G. N. Schramm, *The tarnishing and detarnishing of silver*, Metal Industry (New York), January, March, April, and June 1924.

Melt the waxes by heating in a vessel placed in hot water, add the turpentine and gasoline, and cool the mixture as rapidly as possible, while vigorously stirring to produce a smooth, creamy wax. This formula gives a paste wax. By increasing the amounts of turpentine and gasoline (say to a combined total of about 12 to 15 parts by weight), a more fluid or a liquid wax may be obtained.

(2) Material:		Amounts
Turpentine	----- pint	1
Beeswax	----- ounces	4
Ammonia water (10-percent strength)	----- do	3
Water	----- pint (about)	1

Mix the beeswax and turpentine and heat them by placing the vessel in hot water until the beeswax dissolves. Remove the mixture from the source of heat, add the ammonia and the water, and stir vigorously until the mass becomes creamy. This wax should be applied lightly on varnished or shellacked floors and any excess wiped off at once, as the ammonia may attack the varnish or shellac. When this wax is used on unfinished oak flooring, the ammonia may cause a slight darkening of the wood.

Paste or liquid wax should be applied in very thin coats and thoroughly rubbed with a heavy waxing brush or motor-driven brush, or a heavy block wrapped in burlap or carpet. In preparing a new or refinished wood floor for waxing, it is common practice to apply a coat of shellac varnish or other quick-drying varnish before waxing. If this is done, it is better to have a very thin coating of shellac, as thicker coatings are apt in time to crack or peel, which will necessitate complete refinishing. The wax can be applied directly to close-grained woods such as maple or pine, or to such open-grained wood as oak, if a "silicate wood filler" is first applied. This treatment requires more waxing, and therefore more labor, in the original job, but the finish is likely to be more durable. However, floors finished in this way often darken more readily than if the wax is applied over a thin coat of shellac. Wood floor sealers are now being used for the sealing of close-grained wood or in the sealing of open-grained wood which has been treated previously with a wood filler. The sealed floors are then waxed.

(b) WATER-EMULSION WAXES.—These emulsions, commonly called nonrubbing, "self-polishing" or "dry-bright" polishes or waxes, are now widely used on wood, cement, linoleum, rubber tile, cork, asphalt tile, mastic, and other floorings. Many of these preparations dry rapidly and require little or no polishing. These water-wax emulsions usually consist of carnauba wax (and other waxes) dispersed in a water solution of soap. Sometimes emulsifying agents other than soap are used. A small amount of resins is often used in preparing these emulsions. Synthetic as well as natural products may be used in some of these preparations. A simple carnauba wax-soap-water emulsion may be prepared for *experimental* purposes as follows:

Dissolve 1 part by weight of castile soap in 16 parts of clean, soft water, and heat the solution to boiling. Add to the boiling soap solution with constant stirring 4 parts by weight of a good grade of carnauba wax (cut into small pieces). When a smooth homogeneous emulsion is obtained, cool to a temperature of 135° F by quickly

adding, with constant stirring, the necessary quantity of *cold* water. (This should take about 14 to 16 parts more of water.) Let cool, filter through cheesecloth, and stir in about 0.5 percent of formaldehyde as a preservative. The product so obtained should be of the color and consistency of cream. A thicker or thinner product may be made by decreasing or increasing the quantity of water used, taking care to maintain the given ratio between soap and wax. This wax mixture may require polishing or buffing after drying in order to obtain a glossy surface.

Formulas (see p. 42).

The following information and formulas for the preparation of a "triethanolamine-carnauba wax dry-bright polish" were furnished some time ago by a manufacturer.

"Shellac has been incorporated in this polish to cut down the slipperiness of a straight carnauba wax emulsion. A dry-bright polish can also be made as directed by merely leaving out the shellac solution and adding the water used in it to the wax emulsion. The addition of the shellac seems to make it spread more evenly and, as stated, makes a film that is not quite so slippery. It is necessary to use a good grade of light-colored carnauba wax (known in the trade as 'No. 1'), and the directions for making the polish must be carried out as described. The temperature should never be above 100° C (212 °F) at any time."

The polish is made as follows:

Material:	Trial batch	Large batch
Carnauba wax-----	72 g	13.2 lb
Oleic acid-----	9.1 ml *	1.6 pt, or 1.5 lb
Triethanolamine-----	10.6 ml	1.9 pt, or 2.1 lb
Borax-----	5.4 g	1.0 lb
Water (boiling)-----	500 ml	11.5 gal
Shellac (dry flakes)-----	10.0 g	2.2 lb
Ammonia (28 percent)-----	1.75 ml	0.35 pt, or 165 ml
Water (room temperature)-----	100 ml	2.0 gal

* Milliliters.

Trial Batch: (1) Melt the wax and add the oleic acid. Temperature should be about 194° F. Placing the container in boiling water keeps the polish at a suitable temperature.

(2) Add the triethanolamine slowly, stirring constantly. This should make a *clear* solution.

(3) Dissolve the borax in about 5 ml of the boiling water and add to (2). Stir for about 5 minutes. This gives a clear, jelly-like mass.

(4) Add the rest of the boiling water, *slowly* with constant stirring. An opaque solution should be obtained. Cool.

(5) Add the 100 ml of cool water to the shellac and then the ammonia, and heat until the shellac is in solution. Cool.

(6) Add the shellac solution to the wax solution and stir well. The resulting solution should give a clear film when applied to linoleum, mastic floors, etc.

Glickman²¹ discusses at length the preparation of water-emulsion waxes, giving a number of suggested formulas. In discussing the above formula he states: "Experience indicates that the presence of shellac in the product is of little value. If any ammonia is desirable

²¹ Charles S. Glickman, *Water emulsion waxes*, Soap 12 No. 5, 97, 99, 101, 103; *Emulsion floor waxes*, Soap 12 No. 12, 121, 123, 125, 127, 129, 139 (1936).

in the finished product, it can be added anyway." He suggests the following modification of the above formula and procedure:

Material:	Pounds
Carnauba wax.....	13. 2
Oleic acid.....	1. 5
Triethanolamine.....	2. 2
Borax.....	1. 0
Water.....	131. 2

This formula gives a wax with about 12 percent of total solids.

(1) Heat the wax and oleic acid together in a kettle until a uniform mixture is obtained, and most of the mechanically inclosed water is driven off—until there is no, or very little, foam on the surface. The temperature should be kept close to 212° F.

(2) Add the triethanolamine slowly, with *agitation*, to the oleic acid-wax mixture. In order to insure the addition of *all* of the triethanolamine, the latter may be heated in a separate container until it is very thin (fluid) and then added; the container is then rinsed with some of the borax solution, or, if conditions prevent, with the water used for dilution after the addition of the borax solution. The rinsings should be added to the borax solution, which is preferable, or to the boiling water. The solution after mixing should assume a *clear brown* color.

(3) Raise the temperature of the mixture obtained in step (2) to about 216° to 218° F; add the boiling borax solution (borax dissolved in an equal weight of water) slowly in intermittent batches, if done by hand, and in a very thin stream, if added from another and smaller kettle. The agitation must be continued and the temperature carefully controlled. The mixture, during the addition of the borax solution, should not suddenly become of a pasty yellow color; should this happen, stop adding the borax and stir and heat the mixture until it becomes *clear brown* in color. After the borax has been added, the mixture should be stirred until practically all bubbles have disappeared.

(4) Again raise the temperature of the mixture to 216° to 218° F, and add the water (heated to boiling) slowly, with rapid and thorough agitation. The color of the mixture should remain clear brown. The mixture gradually increases in viscosity, and care should be taken that additions of water are absorbed before further portions are added. When about 60 percent of the total amount of water has been added, the clear brown and viscous mixture suddenly changes in viscosity, showing streaks of the clear brown mass in a milky solution. When *all* of the water (boiling hot) has been added with rapid and thorough agitation, the emulsion should be grayish, fluorescent, and translucent in appearance.

(5) Cool the mixture *rapidly* with the agitation continued. Filter before packaging.

Glickman states that the "Nos. 2 and 3 North Country" grades of carnauba wax seem to give better results as regards particle size and fineness of dispersion than the No. 1 grade. The addition of a material such as shellac to the finished wax dispersion is mainly for the purpose of increasing the gloss of the film. Bleached, dewaxed shellac should be used, if shellac is to be incorporated. The shellac dissolved in ammonia and water or borax solution may be mixed (with stirring) with the cold wax dispersion or the warm mixture, but

should *not* be added to the *hot* wax mixture. In making water-emulsion waxes, care must always be exercised that all of the wax be treated alike with alkali (triethanolamine or other alkali) and acid (oleic acid, etc.), as well as borax, to insure uniformity of dispersion. Robertson and Wilson²² suggest the use of the organic amine, morpholine, in the preparation of water-emulsion waxes. The reader is referred to the original paper for a discussion of the properties of this compound and suggested formulas in which it is used.

The preparation of water-emulsion waxes on a large scale requires special equipment, such as jacketed kettles for heating with steam and cooling with cold water (separate kettles for hot water, for borax solution, and for the wax), stirring devices, and special thermometers.

Water-emulsion waxes are usually applied with a lamb's wool applicator or a cotton cloth mop. These waxes should be applied to clean, dry surfaces and should be spread as thinly as possible. It is common practice to treat the flooring with a suitable sealer before waxing. Sometimes two coats of wax are applied, the first coat serving as a sealer or undercoater. A water-emulsion wax when properly applied should dry to a hard, lustrous film in less than 30 minutes. The gloss of the dried film may be increased by a slight buffing.

An important problem in the use of paste and liquid as well as water-emulsion waxes is the slipperiness of the dry film. Many manufacturers claim to have some ingredient in their products that will give a so-called "nonskid" or "nonslip" wax. However, it is doubtful if there is such a thing as an absolutely skid-proof waxed surface. Small amounts of natural or synthetic resins, rubber, and probably gums have been incorporated in waxes to reduce the slipperiness of the dry film. The product used must be compatible with the other ingredients of the wax and should not impair the polishing or wearing properties of the finished wax.

4. GLASS POLISH AND CLEANER

Polishes for glass are generally powders or pastes. Precipitated chalk, calcined magnesia, crocus or rouge (iron oxide), "putty powder" (tin oxide), and fine siliceous materials are the abrasives usually employed. In addition, they frequently contain soap, sodium carbonate, trisodium phosphate, or ammonium compounds (or ammonia) for the purpose of removing grease, etc.

The most common liquid cleaners for windows and mirrors are clear water or water to which washing soda, borax, ammonia, kerosene, or alcohol has been added. Trisodium phosphate or soda ash might be used instead of washing soda, borax, or ammonia. Alkaline solutions and solutions containing alcohol should not come in contact with paint, lacquer, varnish, or enamel surfaces.

Some of the liquids used for cleaning automobile wind-shields and windows have been essentially solutions containing about 15 to 25 percent by volume of straight grain alcohol or denatured alcohol, colored with a dye and sometimes perfumed. In some cases a little glycerol or ethylene glycol may be present. These solutions are generally sprayed on with an atomizer, and the glass is then wiped

²² H. F. Robertson and A. L. Wilson, *Comments on morpholine in wax polishes*, Soap 14 Nos. 8, 99, 101 111 (1938).

off with a soft cloth. Isopropanol, and probably other alcohols or solvents, are also used.

For example, a mixture of about 8 fluid oz of diethylene glycol, 120 fluid oz of water, and a small amount of ethyl alcohol colored with dye and perfumed, has been reported in the patent literature.

5. STOVE POLISH

Stove polishes may be obtained as powders, so-called liquids, pastes, and sticks or cakes. Graphite is usually the basic ingredient. Finely powdered graphite may be used directly as a stove polish after mixing with a little water. Lampblack, carbon black, and bone black are sometimes added to deepen the color, but these forms of carbon are more readily burned off than graphite. Nigrosine (a black aniline dye) has also been used to deepen the color of such polishes. Stove polishes may contain, in addition to graphite and other forms of carbon, such materials as copperas (ferrous sulfate), soap, "water glass" (sodium silicate), waxes, gums, sugar, glycerol, water, oils, turpentine, etc. Turpentine or other readily inflammable liquids should not be used in such polishes. The liquid polishes are generally of two types: (a) graphite suspended in a water solution of sodium silicate, soap, etc., and (b) a suspension of graphite in a petroleum distillate (oil) mixture, or such a mixture with the addition of carbon tetrachloride to render it noninflammable.

6. SHOE POLISH

The ordinary black shoe polishes generally contain wax (beeswax or carnauba wax), nigrosine (a black dye), sodium or potassium carbonate solution, soap, turpentine, etc. After the wax has been emulsified by boiling in the soda (or potash) solution (a solution of borax may also be used), the emulsion is mixed with a hot aqueous solution of ordinary laundry soap and sufficient nigrosine to give the desired depth of color. This cools to a soft paste. If the liquid form is desired, a good grade of castile soap (pure olive oil-soda soap) or a soft (potash) soap may be substituted for the laundry soap. Another method is to dissolve carnauba wax or candelilla wax or a mixture of the two with beeswax and ceresin or paraffin in hot turpentine and mix with very finely pulverized bone charcoal. Tallow, lard, neat's-foot oil, spermaceti, rosin, gums, and various other materials have been used in making shoe polishes.

Brown shoe polishes consist of such substances as soft soap, wax, glycerol, linseed oil, turpentine, shellac, etc., to which is added some dye; for instance, annatto, aniline yellow, etc.

White shoe dressings are usually made up of pigment, adhesive or binder, cleaner, and water. Sometimes an organic solvent or a mixture of solvents is also used. When glue, albumin, or other organic binder is used, a preservative will be required. Some of these dressings are perfumed. Titanium dioxide, lithopone, zinc oxide, titanium pigment (about 25 percent of titanium dioxide and about 75 percent of calcium carbonate), zinc sulphide, talc, precipitated chalk, china clay, magnesium carbonate, magnesium oxide, and other materials have been used as pigments. Among the cleaners that have been used the following are mentioned: Trisodium phosphate, triethanolamine, soap,

alcohol, and other organic solvents. Various gums (such as karaya and tragacanth), dextrin, gelatin or glue, albumin, bleached shellac solution (in borax or ammonia), casein, and soap have been used as binders or adhesives. Phenol, sodium salicylate, salicylic acid, or a suitable essential oil may be used as a preservative.

FORMULAS (see p. 42).—The following formulas and information have been furnished by a manufacturer:

(1) *Cleaner for such leathers as Russia calf, black or tan vici, and white kid.*—Dissolve 8 oz of granulated castile soap in 1 gal of hot, soft water, add 3½ gal of warm, soft water, cool, add 16 oz of ethyl ether, and mix.

(2) *Patent-leather cleaner.*—Dissolve 4 oz of granulated castile soap in 1 gal of hot, soft water, cool, add 2 qt of denatured alcohol, and then 16 oz of ammonia water (specific gravity 0.90), mix.

(3) *Water polish or dressing.*—Dissolve 1 part by weight of castile soap in 16 parts of clean, soft water, and heat the solution to boiling. Add to the boiling soap solution with constant stirring 4 parts by weight of a good grade of carnauba wax or other suitable wax, as Japan wax or beeswax (cut into small pieces). When a smooth homogeneous emulsion is obtained, cool to a temperature of 135° F by quickly adding, with constant stirring, the necessary quantity of cold water. (This should take about 14 to 16 parts more of water.) Let cool, filter through cheesecloth, and stir in about 0.5 percent of formaldehyde as a preservative. The product so obtained should be of the color and consistency of cream. A thicker or thinner product may be made by decreasing or increasing the quantity of water used, taking care to maintain the given ratio between soap and wax. The polish may be colored by thoroughly stirring in a strong solution of a suitable water-soluble dye; for example, for a black polish, add a solution of 1 part of nigrosine dissolved in 12 parts of water.

(4) *Oil polishes.*—Many of the formulas for an oil polish, such as the turpentine paste polishes, do not include soap at all, being made up of a wax base and a small amount of other materials with about 75 percent of turpentine. Some of the firm paste polishes are made with a small amount of soap, beeswax, ceresin, and carnauba wax, with about 75 percent of turpentine.

Auch²³ has suggested the following formulas to serve as a basis for experimentation in the preparation of white shoe cleaners or dressings:

(5) *Liquid dressing.*

Material:	Parts (by weight)
Lithopone.....	20 to 22.
Disodium phosphate.....	1 to 2.
Bentonite.....	1 to 2.
Perfume.....	0.1 to 0.3.
Water.....	77.9 to 73.8.

This is a mechanical mixture to which any desired amount of a selected binder may be added and a preservative, if required. The lithopone may be replaced in whole or in part with other pigments.

(6) *Cream or paste dressing.*

Material:	Parts (by weight)
Lithopone.....	60 to 65.
Toilet soap chips.....	6 to 8.
Sodium silicate.....	0.3 to 0.5.
Perfume.....	0.3 to 0.5.
Water.....	33.4 to 26.

²³ Ralph H. Auch, *White shoe cleaners*, Soap 13 Nos. 11, 26 (1937).

The addition of a small amount of talc or zinc stearate would aid in the application of the paste. The paste should be packed in tin tubes. Aluminum would be attacked by the alkaline mixture and lead would be affected by the lithopone, giving the paste a dirty gray color.

(7) *Emulsion type dressing.*

Material:	Parts (by weight)
Titanium pigment.....	20 to 24.
Triethanolamine.....	0.9 to 1.2.
Gum damar.....	2 to 4.
Oleic acid.....	2 to 2.5.
Carbon tetrachloride.....	10 to 12.
Naphtha (gasoline).....	12 to 14.
Water.....	53.1 to 42.3.

Mix the carbon tetrachloride and naphtha, dissolve the damar in the solvent mixture, and then add the pigment, with stirring, to the solution. Dissolve the triethanolamine in the water, warm to about 135°F and add the oleic acid slowly with agitation. Then, while stirring vigorously and continuously, add the gum-pigment-solvent mixture in a thin stream to the soap-water solution. Care, skill, and preliminary experimental work are required to obtain a stable emulsion. This formula may be varied, as determined by experiment.

The following formula has been suggested for a leather preservative that will permit polishing:

Material:	Parts (by weight)
Carnauba wax.....	2
Beeswax.....	2
Neat's-foot oil.....	1
Turpentine.....	4

Melt the mixture of waxes and neat's-foot oil by heating in a vessel placed in hot water, add the turpentine, allow the mixture to become homogeneous, and remove from hot water; then immediately stir *vigorously* and *continuously* until the mixture is cool (room temperature). After the mixture has cooled somewhat, the vessel containing it may be placed in cold water to hasten the cooling, but the stirring must be continued.

If the above formula gives too stiff a paste, the turpentine may be increased to 5 or 6 parts by weight. This would have to be determined by experiment. A stirring or mixing device and jacketed vessels (for hot water and then cold water) would be advisable for quantity production. This mixture should be applied to the clean, dry leather with a rag, rubbed hard until no more material is absorbed, and finally polished with a clean cloth. A higher polish will be obtained by reduction of the quantity of oil, but the leather will not be so well preserved.

7. POLISHING CLOTH

Cloths used for polishing furniture may be of cotton, wool, or silk. Some firms use cheesecloth and others use a wool cloth made specially for the purpose. Cheesecloth is probably the easiest to obtain, since it is not made specially for polishing and is the most economical. Wool and silk cloths are more expensive and when made for polishing furniture are usually woven so as to be soft and nonabrasive.

Polishing cloths or rags intended primarily for use on metals usually consist of woolen fabrics which have been saturated with fatty oil, mineral oil, or paraffin, or mixtures of these, containing in suspension a very finely powdered abrasive, such as tripoli or infusorial earth. Fatty acids have been used with paraffin in the preparation of such cloths, but may cause corrosion on some metals if a film of the acid remains. Muslin rags are also in use. Suspensions of tripoli (or other abrasive) in soap solutions, or mixtures of soap solutions, pine oil, ammonia, etc., have also been used for preparing polishing cloths. Some of these mixtures are colored with dyes and may contain a little essential oil. A polishing cloth might be prepared as follows: Dissolve a fatty oil (such as cottonseed oil), mineral oil (transformer oil or paraffin oil), or paraffin in gasoline, add the abrasive and mix thoroughly, pass the cloth through the suspension, and then stretch the cloth and allow to dry in this condition. If a vegetable oil (linseed, cottonseed, etc.) is used on wool, dry in a good circulation of air in a cool place not exposed to direct sunlight, in order to avoid danger of spontaneous combustion.

8. DUST CLOTH, OILED

These cloths are commonly referred to as "dustless dust cloths." Such cloths may be made by saturating a fabric with kerosene, hanging up to allow the more volatile part to evaporate, and then rubbing the oiled cloth on a wooden surface until it no longer streaks. These cloths may also be made by saturating them with a gasoline solution of paraffin, paraffin oil, linseed oil, or rapeseed oil, or a mixture of these, wringing out, and drying at room temperature. Sometimes essential oils or certain resins are added to the impregnating mixture.

X. SWEEPING COMPOUNDS (ALSO KNOWN AS "FLOOR SWEEP" AND "DUST DOWN")

Although there are many floor-sweeping compounds or preparations on the market made up of sawdust, sand, ground feldspar, coloring matter, oil, wax emulsions, disinfectant, etc., it is believed that fine sawdust moistened with water at the time of use will prove satisfactory for this purpose. Crumpled, dampened bits of paper and moist tea leaves are sometimes scattered over floors prior to sweeping in order to hold dust.

The Treasury Department at one time used a compound made up according to the following formula:

Material:	Parts (by weight)
Sand.....	10
Fine sawdust.....	3. 5
Salt.....	1. 5
Paraffin oil.....	1
<i>Mix thoroughly.</i>	

Certain Government offices have advised that a compound conforming to the following formula has been satisfactory in service:

Material:	Parts (by weight)
Fine sand.....	35
Pine sawdust.....	40
Paraffin oil.....	15
Water, and dye if coloring is desired.....	10

Some of the commercial compounds are colored with iron oxide or other pigment and some contain naphthalene flakes, paraffin wax, etc. Essential oils, such as oil of eucalyptus, oil of sassafras, etc., are frequently added to impart a pleasant odor to the compound or to mask any unpleasant odor of the ingredients used. Pine oil disinfectant, a small amount of creosote oil, and probably other materials, might be used as disinfectants.

The water-wax-emulsion type of sweeping compound is an outgrowth of the development of the water-emulsion floor waxes. In this type, the mineral oil is replaced with waxes, resins, water, and emulsifying agents. Instead of leaving a thin film of oil on the floor, a film of wax may be deposited. The wax type of sweeping compound is intended for use on floorings that may be affected by oils, such as linoleum, rubber, asphalt tile, mastic, and polished wood.

Cummings²⁴ gives the following information on coloring sweeping compounds:

Water- or oil-soluble red or green is used. The water-soluble green is malachite green. The water-soluble red is croceine scarlet. The best oil-soluble green is an alizarin oil green, the red is an azo oil red. Where the water-soluble colors are used, the color is dissolved in water and the sawdust is colored first. Then the oil and sand are added afterwards. If the oil-soluble colors are used, the oil is colored first and then mixed thoroughly with the sawdust and the sand is added afterwards. The whole mass is then thoroughly mixed.

Sisal hemp tailings from cordage factories is used, instead of sawdust, in the manufacture of certain sweeping compounds of the mineral oil-sand type.²⁵

The Cotton Research Foundation, Memphis, Tenn., has recently developed a sweeping compound consisting of about 95½ parts by weight of cottonseed hull bran and 4½ parts by weight of paraffin oil.²⁶

The Government Departments buy sweeping compounds on Federal Specification P-C-591 (see page 58).

XI. WALLPAPER CLEANER

The basic ingredient of many wallpaper cleaners is gluten, which may be supplied satisfactorily by the use of rye or wheat flour. The flour is made up into dough with water or with water containing 25 to 35 percent of common salt. Preservatives may be added, such as sodium salicylate, sodium benzoate, borax, or certain essential oils. The latter are also added to impart a pleasant odor. Stale bread, usually rye bread, may be cut into slices and used as a wallpaper cleaner. Wheat bran (sewn up in a bag), pipe clay, and various other materials have also been used. "Artgum" is also used for cleaning wallpaper.

XII. FLOOR OILS

A mixture of one part of boiled linseed oil (a drying oil) and three parts of turpentine has been used as a floor oil. However, the floor oil in common use is a well-refined petroleum oil with a flash point not lower than 275° F, such as paraffin oil. These oils are nondrying, are often scented or perfumed, and sometimes colored.

²⁴ S. N. Cummings, *Coloring Soap and Sanitary Products*, Soap Blue Book, 1934, p. 136.

²⁵ See U. S. Patent No. 1,545,571.

²⁶ H. S. Olcott, *Sweeping compound*, Soap 14, No. 11, 105 (1938).

After washing a floor, it should be allowed to dry before oil is applied. The time of drying will depend upon the kind of wood, the degree of wetness, and the atmospheric conditions. It would seem that a floor might be oiled the same day it is washed, provided it is wiped dry and the weather conditions and ventilation facilities are favorable for rapid evaporation of moisture. However, it would probably be safer to wait until the next day before applying the oil. After the oil is applied, it should be rubbed off until only a thin film remains, in order that the floor may not be too slippery. However, some woods may absorb the oil more readily than others and not require subsequent rubbing.

The oiling of floors is often objectionable in that the oil tends to hold dust and dirt. However, the petroleum type of oil is used on wood floors (generally old or badly worn floors) to keep dust down.

It is believed that waxing is the most satisfactory treatment for wood floors. The wax may be applied to the clean floor that has been previously treated with a wood filler, or to a floor that has been shellacked, varnished, or treated with a sealer.

XIII. SPECIFICATIONS

1. GENERAL

Large consumers, such as the various branches of the Government service, municipalities, etc., have for many years purchased various materials under definite specifications, which have a great variety of requirements for the same kind of material.

Purchasing materials under specifications necessitates sampling and testing, which are costly operations; hence, it is advisable to purchase under specifications only when the amounts delivered are large. When the amount purchased is small, it is more economical to buy a brand desired than to incur the expense of testing a product offered at a low price.

It would be of distinct advantage to both manufacturers and consumers if one specification for any particular type of material could be generally used by a large number of consumers. Such a specification should secure a product suitable for the intended use, but, as far as possible, admit material of regular commercial makes. It should allow the greatest freedom, consistent with quality, in the selection of stock so that the manufacturer can take advantage of both varying market conditions and advances in technology and thus prevent, as far as possible, excessive prices due to temporary scarcity in any specific raw material. Methods of sampling and testing should be clearly defined and be made a part of the specification.

A method for reducing or eliminating the testing of deliveries, involving the certification by the manufacturer that the goods delivered by him comply with the requirements of certain specifications, has been introduced by the National Bureau of Standards; and manufacturers desiring to do so are encouraged to use quality-guaranteeing labels for identifying such goods for the benefit of consumers who do not use specifications.

The National Bureau of Standards has prepared, in cooperation with the manufacturers, a recommended specification for so-called powdered ammonia. This has been issued as Bureau of Standards Letter Circular No. 124, obtainable on request from the Bureau.

A specification for dry-cleaning solvent (Stoddard solvent) has been prepared by the National Bureau of Standards in cooperation with the National Association of Dyers and Cleaners of the United States and Canada, and with the petroleum producers and refiners. This specification has been published as National Bureau of Standards Commercial Standard No. CSD3-38. This publication is available by purchase from the Superintendent of Documents. The price is 5 cents. (See under Federal Specifications).

2. FEDERAL SPECIFICATIONS

The Federal Specifications are formulated by technical committees appointed from the Government personnel and are used by the various branches of the Government in the purchase of supplies. These specifications are not published by the National Bureau of Standards, but a list of those relating to detergents and similar materials is given below. These specifications can be purchased at 5 cents a copy, unless otherwise indicated, from the Superintendent of Documents. "Federal Standard Stock Catalogue, Section IV, Federal Specifications, Part I, Index," which lists all Federal Specifications, with prices, can be purchased, price to be obtained from the Superintendent of Documents.

Remittance should be made by coupons (which may be purchased from the Superintendent of Documents in sets of 20 for \$1.00), postal money order, express order, or New York draft payable to the "Superintendent of Documents, Government Printing Office, Washington, D. C." Currency may be sent at sender's risk. Postage stamps should not be sent, and defaced or smooth coins, or foreign money positively will not be accepted. Publications are forwarded under Government frank to addresses in the United States and its possessions; also to Mexico and Canada.

Specification symbol	Title	Specification symbol	Title
OO-L-131b...	Laundry-Appliances. (Price 10 cents.)	P-P-596.....	Powder; Scouring (for) Highly Polished Glass.
OO-M-31a....	Machines, Dishwashing; and Dish-baskets.	P-S-536.....	Soap and Soap-Products; General Specifications (Methods for Sampling and Testing).
O-A-76.....	Acid; Acetic, Technical.	P-S-566.....	Soap; Chip.
O-A-91.....	Acid; Oxalic, Technical.	P-S-571.....	Soap; Grit, Cake.
O-A-451.....	Ammonia, Aqua (Ammonium-Hydroxide), Technical.	P-S-576.....	Soap; Grit, Hand.
O-B-441a....	Bleaching Material (Chlorinating Agents).	P-S-586.....	Soap; Laundry, Liquid.
O-B-491.....	Bluing, Laundry.	P-S-591.....	Soap; Laundry, Ordinary.
O-S-571.....	Soda-Ash.	P-S-586.....	Soap; Laundry, Powdered.
O-S-581.....	Sodium Carbonate; Granular (Monohydrate Crystals).	P-S-606.....	Soap Powder.
O-T-671.....	Trisodium Phosphate; Technical (Phosphate Cleaner).	P-S-611.....	Soap; Salt-Water.
O-G-491.....	Glycerin (Glycerol).	P-S-612.....	Soap, Soft; (for) Automobile and General Cleaning.
C-C-91.....	Candles.	P-S-613.....	Soap; Soft, Potesh, Linseed Oil.
JJ-N-176....	Nets, Laundry; Bag-Type.	P-S-616.....	Soap; Toilet, Floating, White.
JJJ-S-701....	Starch; Laundry.	P-S-618.....	Soap; Toilet, Liquid.
SS-B-611....	Borax (Sodium-Borate).	P-S-621.....	Soap; Toilet, Milled.
W-M-46.....	Machines, Floor-Polishing and Scrubbing; Electric.	P-S-626.....	Soap; Toilet, Powdered, (for) Dispensers.
P-C-591.....	Compound; Sweeping.	P-S-631.....	Soda; Caustic (Lye); (for) Cleaning Purposes.
P-D-221.....	Detergent, Hand; Paste and Powder (for) Mechanics' Use.	P-S-641.....	Soda; Laundry (Washing Soda).
P-O-361.....	Oil, Floor; Mineral.	P-S-661a....	Solvent; Dry-Cleaning.
P-P-556a....	Polish; Metal, Paste.	FFF-C-641..	Cream and Soap; Shaving.
P-P-571a....	Polish; Silver.	P-W-141.....	Wax, Floor; Liquid and Paste.
P-P-591.....	Powder; Scouring (for) Floors.	P-W-151.....	Wax, Floor; Water-Emulsion.
		FFF-D-396a..	Dispensers; Soap.

XIV. REFERENCES

1. WATER, SOAPS, ALKALINE CLEANSERS, AND MISCELLANEOUS DETERGENTS

[NOTE.—This circular lists only a few of the books and journal articles that contain information on the subjects covered by it. References to publications, including patents, that have appeared in the literature during the past 30 years may be found in Chemical Abstracts, published by the American Chemical Society and available in many technical and institutional libraries.]

Many public, college, and university libraries throughout the country have publications of the Bureau, and possibly also publications from other branches of the Government. Those in print can be bought from the Superintendent of Documents, United States Government Printing Office, Washington, D. C., for the prices stated. Postage stamps should not be sent, and defaced or smooth coins or foreign money positively will not be accepted. Currency may be sent at the purchaser's risk. Postal money orders, or coupons sold by the Superintendent of Documents in sheets of 20 for \$1 are accepted. The coupons are good until used. In ordering, the name of the Bureau or Department as well as the title and number of the publication should be given.

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WASHINGTON, January 27, 1939.

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